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**27 Days at DEFCON 2**



**New from Tom Hanks**  
**Apollo in IMAX 3-D**

# AIR & SPACE

Smithsonian

## LORD OF THE SKIES

### F/A-22 RAPTOR

PHOTOS FROM  
THE SURFACE:  
SATURN'S  
STRANGE  
SATELLITE

SHUT UP!  
STIFLING SONIC  
BOOMS

PAGE 50

F/A-22 RAPTOR

P-38 LIGHTNING

NOVEMBER 2005



# World's Most Valuable Timepiece Disappears

**B**ack in 1933, the single most important watch ever built was engineered for a quiet millionaire collector named Henry Graves. It took over three years and the most advanced horological technique to create the multifunction masterpiece. This one of a kind watch was to become the most coveted piece in the collection of the Museum of Time near Chicago. Recently this ultra-rare innovation was auctioned off for the record price of \$11,030,000 by Sotheby's to a secretive anonymous collector. Now the watch is locked away in a private vault in an unknown location. We believe that a classic like this should be available to true watch afficianados, so Stauer replicated the Graves design in the limited edition Graves '33.

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**Cover:** In the twilight of conventional fighter technology, the storied P-38 Glacier Girl flies honor guard with the aircraft ushering in the new order: the F/A-22 Raptor. Photo by Erik Hildebrandt.

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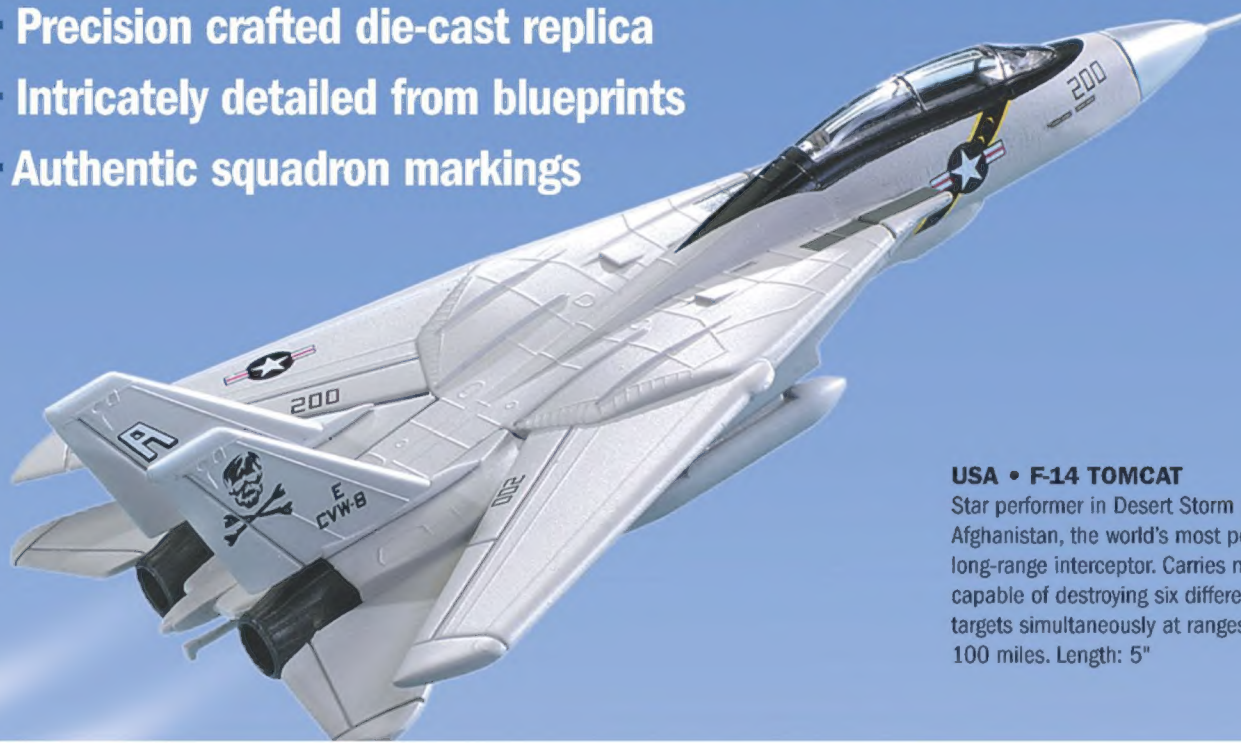
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## The Blue Crew

The opening of the Steven F. Udvar-Hazy Center in Virginia redefined the National Air and Space Museum, making it the largest complex of its kind in the world. Because helping people make the most of their visit is a priority for us, we have developed innovative ways to serve them: For one, we established a new division—Visitor Services. Begun as an experiment, the division proved successful and became operational at both Museum locations in September 2004.

The backbone of the program is a cadre of volunteers trained to greet and engage people. Nicknamed the “Blue Crew” because of their distinctive vests, the members of this group help to orient visitors to the Museum’s vast spaces and hundreds of artifacts, displays, and attractions.

Pat Bellacicco, who manages the division, introduced a comprehensive training program, but what gives the program its edge is the fact that the Blue Crew members are all volunteers. “That means they really want to be here,” says Bellacicco. “Enthusiasm makes all the difference.”

According to General Joe Anderson, Associate Director for the Udvar-Hazy Center, another secret of the program’s success is the passion Blue Crew members share for the subject matter. “Many Visitor Services volunteers have been or are currently involved in aviation in some way,” Anderson says, “and establish a rapport by sharing anecdotes and experiences with people.”

The hubs for Visitor Services operations are the newly established Welcome Centers, a concept introduced at the flagship building in 2002. At that

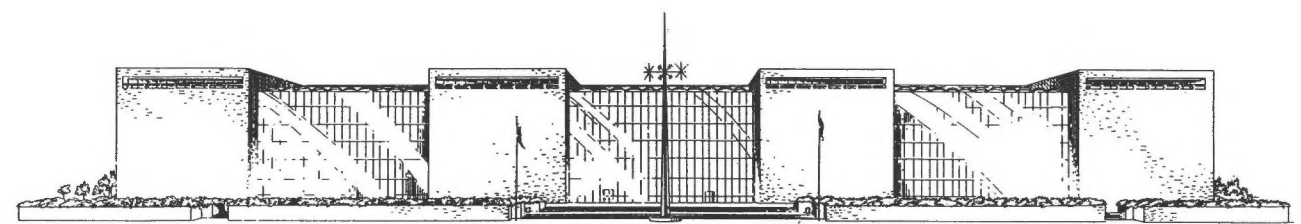
time, we created a single, central location for promoting information and services. We installed colorful, illuminated signage that paved the way for a more coordinated system of way-finding, both inside and outside the Museum. Because it worked so well, the Mall building Welcome Center became a model for one in the Udvar-Hazy Center.

Operating two separate locations means we now have many more artifacts to share, more stories to tell, more services and amenities to offer. We hope visitors will be able to go to both locations, and the National Air and Space Museum Express provides buses between the sites and serves as the principal direct link to both. Tickets for the Express and our other attractions are sold at both Welcome Centers. And the “one-stop shopping” concept promoted by Blue Crew members ensures full, enjoyable visits for all.

The success of the new program was evident almost immediately: At the Udvar-Hazy Center, which celebrated its first anniversary on December 11, visitors are spending more time than we had anticipated.

Throughout 2005, the Museum will continue to be a work in progress. On November 1, 2004, the Center’s James S. McDonnell Space Hangar became fully operational. New artifacts are being installed in the Aviation Hangar, including the vertical flight collection. An exciting IMAX film, *Fighter Pilot: Operation Red Flag*, opened at the Center and is now showing at the Mall building as well.

—J.R. Dailey is the director of the National Air and Space Museum.



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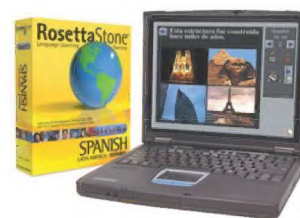
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## LETTERS

### Fans of the Convair

"Planes, Trains, and Waterfalls" (Aug./Sept. 2005) sparked memories of my very first airplane flight. It was 1971, and I was a high school senior on a trip to visit colleges. I flew on a Convair 580 operated by Allegheny Airlines out of Friendship Airport, now Baltimore-Washington International. While I waited with my father to check in, a businessman in front of me turned to his companion and said, "Allegheny has two classes: fifth and sixth." That didn't matter to me; since I intended to pursue a degree in aeronautical engineering, any airplane would have been fine.

We passengers walked the ramp and climbed the airstairs (there were no jetways then). I got a seat over the wing so I could watch propeller, flaps, and aileron.

With this admitted bias, I must respectfully disagree with author Sam Goldberg's dismissal of the 580 as a "failure." Of the several modifications of piston-powered 240/340/440 airliners into turboprop-powered versions, the 580 was produced in the greatest numbers. Almost all of these conversions involved older aircraft; none of the CV-580s were new. Of the 424 non-military CV-340/440s produced, 170 (40 percent) were converted to 580s, giving them useful improvements in performance.

Robert M. Dowgwillo  
St. Louis, Missouri

Convair named the 440 the Metropolitan, not Metroliner. And the civil type did not carry a flight engineer, although RovosAir may have decided to add this position. As for the statement "Convair also offered an option to extend coach class by eight seats, to 52," back then, the 52-seat option was still a first-class configuration, not coach.

Jon Proctor  
Sandpoint, Idaho

### Lake Mead's Treasure

After reading "The National Park Service's Bomber" (Soundings, Aug./Sept. 2005), I checked the National Recreation Area Web site ([www.nps.gov/lame/05-004.html](http://www.nps.gov/lame/05-004.html)), which reports: "This area remains closed to SCUBA and all forms of underwater diving unless a permit has been issued by the Chief Ranger's Office. The restriction is necessary to protect a sensitive archaeological resource, the submerged

B-29 aircraft, while the National Park Service completes a resource protection plan for the area.... The diving restrictions will be reevaluated in January 2006."

Also, on one Web forum, people have reported that a number of "trophies" have already been taken from this airplane, and speculated that if restrictions are lifted in 2006, the airframe will be plundered of anything that can be removed. This airframe is said to be in a condition suitable for restoration to airworthy condition—if it can be recovered before it gets looted.

Peter R. Green  
Southend-on-Sea, Essex  
United Kingdom

The photo in your B-29 article seems to show the propeller in a feathered position. Since it takes time for a prop to feather, I wonder how the pilot managed to do that before the aircraft went down. Also, the background of the photo, although murky, seems to indicate that this is the only engine that did not separate from the airframe.

Bill Glaze  
Capt., United Airlines (ret.)  
via e-mail

*Editors' reply: According to an account on the Web site of a diving and sonar company ([www.indepthconsulting.com/B29/B29Lost.htm](http://www.indepthconsulting.com/B29/B29Lost.htm)), the aircraft's first contact with the water "ripped 3 of the B-29's 4 engines from their mounts, set fire to the fourth and severely damaged the left wing and horizontal stabilizer. While initially the pilots were able to regain perhaps 200–300 feet of altitude with the plane's momentum, its fate was sealed. Within a few seconds the B-29 was on its way back down to the water.*

*"Fuel cutoffs were engaged and engine #1 was feathered as the pilots prepared the plane for ditching. They managed to bring it in tail first, slowly decelerating until finally the plane came to rest."*

### Another Propeller Mystery

I have a little story about an aircraft similar to the Bell P-59 ("A Bell That Didn't Ring," Restoration, Aug./Sept. 2005), which we saw in either late 1944 or 1945. I was serving on a U.S. Navy 63-foot "crash boat," cruising the Chesapeake Bay between Solomons Island, Maryland, and the Naval Air Station at Norfolk, Virginia,



## LETTERS

and one day we saw what first looked like a Bell Airacobra. As we watched it come down close to sea level, someone commented: "I don't see a prop." It climbed out of sight and we never found out what it was. I later learned that the nearby Patuxent naval base in Maryland worked with experimental craft, so perhaps this was a P-59.

David G. Morgenstern  
Studio City, California

### The Multi-Talented Talon

"White Rocket" (Aug./Sept. 2005) states: "NASA operates a large fleet of T-38s as trainers, space shuttle approach simulators, and astronaut runabouts." While NASA does operate T-38s for training and astronaut transportation, the role of shuttle approach training is performed by specially configured Gulfstream 2 corporate jets. I believe NASA has two.

Roger Curtiss  
Newbury, Ohio

What's with the four Iron Crosses near the top of the vertical stabilizer of each of the T-38s in the cover photograph?

R.T. Yuncik  
Pinehurst, North Carolina

*Brian Shul, the photographer and a former SR-71 reconnaissance pilot, responds: The squadron at Beale Air Force Base that manned the SR-71 was the First Strategic Reconnaissance Squadron. This was the oldest active squadron in the Air Force, dating back to World War I, when it was a unit conducting balloon observations over the trenches in Germany. The Maltese crosses on the Beale T-38s represent the squadron's origins. Sadly, today the Beale T-38s are painted black.*

Down with the Talon! Some fans of the U.S. Air Force Thunderbirds, myself included, hated the T-38. It might have been fast, but it was definitely not aerobatic. The T-38 took the thunder out of the Thunderbirds. The team's airshow performances were lackluster, they flew only five airplanes, and they couldn't perform some of their trademark maneuvers.

In 1981, two pilots were killed in separate incidents. The next year, during training at Nellis Air Force Base in Nevada, all four pilots in the diamond formation were killed while executing a loop, and the Thunderbirds' season was



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A&S 11-05



cancelled. The next year, they switched to the F-16, and the thunder was back!

Jonathan Hayes  
Hermitage, Tennessee

### Martin Mars: Make More

"The Rainmakers" (Aug./Sept. 2005) was timely. The governor of my home state, Washington, just declared a state of emergency, and dozens of fires are burning across many western states. The National Guard is stretched thin in personnel and equipment, and our aging fleet, as you pointed out, is not being updated with new aircraft.

All this reminded me of one of my favorite articles ever in *Air and Space*: "Dan McIvor's Mars Mission" (Oct./Nov. 1993), about the conversion of the huge Martin Mars flying boats into water-bombers. They can refill their bellies by skimming along a lake or reservoir and dump the water before other airplanes have rolled to a stop on a runway.

Is it possible that the worldwide demand for water tankers is large enough to support the manufacture of an updated version (turboprops and current avionics) of these glorious beasts?

E. Bart Wuest  
Walla Walla, Washington

*Editors' reply: The Russian Beriev Be-200 and Canadair CL-415 are two examples of modern jet- and turboprop-powered scooper-type fire bombers.*

### Tucson-Bound

"Peacemaker Tug of War" (Soundings, Aug./Sept. 2005) states that the B-36 Peacemaker is going to a museum in Pima, Arizona. That is sort of correct; the aircraft is going to the Pima Air and Space Museum, which is in Tucson, Arizona, located in Pima County.

Martin Ghazarosian  
Tucson, Arizona

### A Name You Should Know

I teach at a high school located about three hours from John Young Parkway in Orlando, Florida. Most of my students have driven on or past the parkway, but sadly, very few know who John Young is. Thanks for publishing "Spaceman" (Aug./Sept. 2005) and making more people aware of this true American hero.

Frank Lock  
Englewood, Florida



Photographer Hans Groenhoff's mysterious lady and the Afghan were no mystery to one reader, who found a startlingly similar image in his family photo album.

### I Know Her!

Imagine my surprise when I saw a picture of an old friend, Marion Florsheim (Sightings, Aug./Sept. 2005). Enclosed is an almost identical picture from our family album (above). She raised Afghan hounds, like the one pictured, and after she sold one to my mother's parents, they all became close friends. She was married to an East Coast industrialist, "Mickey" Florsheim, flew her own airplane, and ferried bombers for the Women's Flight Training Detachment during World War II.

I was 14 years old in 1946 and in love with this beautiful and exciting lady, and remember looking forward to her visits and seeing her at dog shows around the country.

Herb Harpham  
Avon Lake, Ohio

### Replica, Reproduction, or Reissue?

"The French-Russian Connection" (Aug./Sept. 2005) says that Christophe Jacquard currently flies a "reproduction" Yak 3. I could be wrong, but my guess is he's flying a new factory-built Yak. In the early 1990s, a group from the United States negotiated a deal with the Yak factory. The factory still had the original tooling in storage, and it agreed to build 10 brand-new Yak 3s. However, the original Klimov engine was not available, so an Allison V-12 was used, which is supposed to give performance

that is similar to the Klimov's.

Several of the aircraft were sold in the United States. I enjoyed watching one race at the Reno air races on two occasions, and Bob Hannah had one in a hangar next to the Warhawk Air Museum in Nampa, Idaho.

Bob Neufeld  
Meridian, Idaho

### Corrections

Aug./Sept. 2005 "The French-Russian Connection": (1) The aircraft builder's name is Dewoitine, not Diwoitine. (2) Only Marcel Lefevre was posthumously named a Hero of the Soviet Union. Jacques Andre was not; he did not die until 1988.

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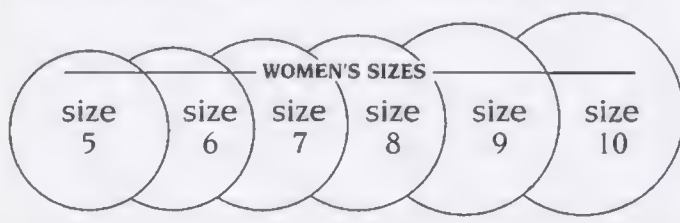
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# Romancing the Runway

No one's planning a "Save Van Nuys" rally yet, but at least one citizen of California's Van Nuys Airport, the nation's busiest general-aviation facility, went to DEFCON 3 after the midnight raid on Chicago's Meigs Field. Mayor Richard M. Daley sent in the bulldozers to tear up the

sprawl at an alarming rate, the unique success and scope of Van Nuys make it a focal point for a discussion about airport infrastructure. But what to some is the sound of commerce and freedom is to others an intrusion into the quality of life. Ironically, the very attribute that helped give birth to what became Van Nuys

Metropolitan Airport—Van Nuys' original name—the basis for his debut film.

For three years, Terwilliger pressed on with pre-production—researching, gathering resources, and assembling a cast and crew. He finally began rolling high-definition video cameras in October 2003, then spent two years filming interviews and editing the 120 hours of footage down to the final 73 minutes of *One Six Right: The Romance of Flying*, now available as a DVD from his Web site, [www.onesixright.com](http://www.onesixright.com). (Runway 16R is the most-used runway at Van Nuys.) The film also ran in a Los Angeles theater for a week in order to qualify as an entry for Best Documentary in the 2005 Academy Awards.

*One Six Right* covers the gamut of general aviation, from corporate jets to J-3 Cubs and Fleet biplanes out for a skim over the shore to warbird trainers taking off in formation. A student pilot learns to work the radio and a helicopter lifts off to save a life. Pilots talk reverently of the need to go to the airport simply to watch and listen. The experience of being a citizen of the airport emerges as part of being a pilot.

The Los Angeles Metropolitan Airport began with one building in an open field in the fall of 1928; it had "two smooth all-weather runways" and a healthy dose of optimism. In 1949, it was sold back to the city for a token \$1 and renamed the San Fernando Valley Airport. That it still exists is due in large part to its development into the Van Nuys Army Airbase during World War II and the 1957 extension of the main runway to 8,000 feet to support corporate jets, which contributed to its status as the busiest general aviation airport. It's now the largest employer in the San Fernando Valley.

After the film's brief run in Los Angeles last August, Terwilliger says that several people e-mailed him that they were inspired to start taking flying lessons at Van Nuys.

—Larry Lowe



California's Van Nuys Airport, the nation's busiest general aviation facility, takes center stage in the documentary *One Six Right*.

lakeside runway in March 2003. "We have an extremely vocal community who hates the airport," says Brian Terwilliger, who flies a Cessna 182 from Van Nuys. "It's not an imminent threat, but pretty much every general aviation airport is in danger."

The worry is well founded. In the past, there were as many as 66 airports in the greater Los Angeles area, with about 15 in the San Fernando Valley. Now only Van Nuys and Whiteman remain. With general aviation losing private airports to urban

airport—land values—now threatens it.

During a chance conversation in 2000, Terwilliger was shooting the breeze with another pilot and mentioned that he flew out of Van Nuys. The instant recognition by the other pilot convinced him that Van Nuys was indeed something special. Two years later, Terwilliger, then 23 and with eight years' freelance experience in the filmmaking industry, set out to make a documentary that would convey to non-pilots the allure of flight. He decided to make the colorful history of Los Angeles

TERWILLIGER PRODUCTIONS



# Moonstruck

Manhattan, just before dusk. Jeffrey Jacobs sets up his eight-inch telescope on the sidewalk on the corner of Bleecker Street and Sixth Avenue, in Greenwich Village, where the buildings barely scrape the sky. He focuses on the crescent moon in the southwest, a few degrees above a brick townhouse. Then he waits—but not for long. A family of four walks past, all staring at the telescope.

"Come look," Jacobs invites them. They pause, their faces betraying suspicion. What's he selling? This is New York City. Everyone's scamming someone.

"Come take a look," Jacobs urges. He's a neat, graying man wearing steel-rimmed glasses, khaki pants, and a light blue Hawaiian shirt. The family hesitates, but Dad decides that Jacobs presents no threat. He peers first.

"Wow," says Dad, turning it over to Son.

"How many craters can you see?" Jacobs asks Son, who's wearing braces and an earring.

"Eighteen," he says, shrugging. Tough crowd. It's hard to impress a 13-year-old.

Other passersby spot the family and the telescope. Curiosity gets the best of them.

"You just bring it out?" someone asks Jacobs.

"Yes."

"Even if it's really cold?"

"Yes." Jacobs, 60, preaches astronomy on Manhattan's sidewalks maybe 10 nights a month for a couple of hours at a time, when it's cloudless and the moon or Jupiter or Saturn is visible in the early evening. He has a job, as well as a wife whom he doesn't want to turn into an astronomy widow. Sidewalk astronomers have their own Web site ([sidewalkastronomers.us](http://sidewalkastronomers.us)), and two unwritten rules. Rule Number One: Share the telescope.

"Can I see?"

"Absolutely," Jacobs says. "Come take a look."

A gay couple saunters up. "Any green moon men?" the shorter man asks.

"Most of them are on Bleecker Street," Jacobs says. "Come, take a look." The shorter one peers into the eyepiece. Then his partner does the same.

"What do you think?"

"I think it's made of cheese," the partner says.

"Wow!" exclaims a woman in a white T-shirt while she takes a look. "Thank you."

"That's amazing," a bearded man says.

"Yes it is," Fox says. "It's your moon."

"Can I look?" says a tall, thin woman

puffing on a cigarette.

"Absolutely," he tells her.

"Thank you."

"You're welcome."

"You want to look at the moon?" he asks a woman wearing a green shirt and black pants.

"Sure," she says, walking over.

"All of Manhattan can fit into one of those craters," he tells her.

"Holy crap!" she says.

"Do you just hang out on

the corner with your telescope?"

"Yes. What could be more fun?"

"I want your telescope."

An hour passes, the sky darkens, and Jupiter blooms a few degrees to the right of the crescent moon. Jacobs turns the telescope. A man peers into the eyepiece.

"I see four stars in a line around it," he says after a moment.

"Those are the Galilean moons," Jacobs says.

"I can see bands across it. It's tiny."

"More than thirteen hundred Earths can fit inside," Jacobs says.

"It moves out of view within a couple of minutes," a Hispanic man adds.

"That's because we're moving," Jacobs tells him. "Seven hundred miles per hour." The man pauses to consider that.

"We get so little astronomy in school," Jacobs explains later. "Yet it's exciting, the effect that it has on people. They're walking by, inside their own heads, then someone stops them to show them our own moon. They're so grateful for that."

A black woman with short hair passes by. "Deep Space Nine!" she calls out, and keeps on walking.

Jupiter slowly descends behind the building, so Jacobs refocuses on the moon.

"Let me get my glasses on," says a

woman with long hair.

"You don't need glasses," Jacobs says. "Lean in slowly and take a look. Adjust the eyepiece."

"It's rocky. It looks beat-up," she says. "You want money?"

"It's your moon," he says, almost defensively. "We don't talk money. Ever." (That's Rule Number Two.)

"Wow!" she says, bending over the telescope for another look. "It's amazing. Are you going to be here tomorrow?"

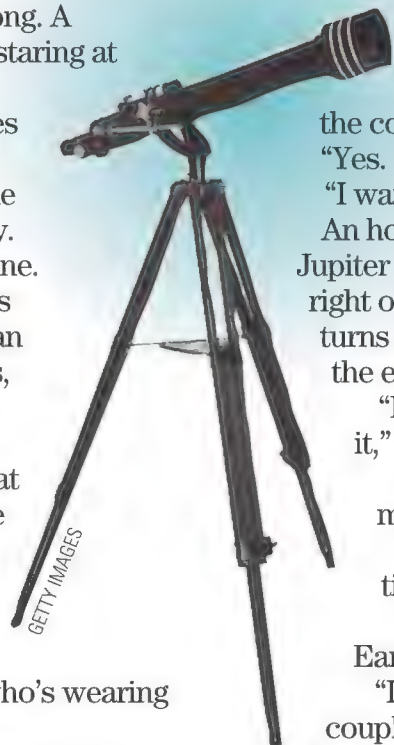
"No ma'am," he says, "but I'll be here next week."

"Thank you," she says. "Thank you so very much."

"You're very welcome."

"Thank you," she says again, before she disappears in the crowd.

—Phil Scott



## Pssst: Want a Mega-Runway?

With the last 220-mph touchdown of a winged orbiter at Florida's Kennedy Space Center slated for sometime in 2010, NASA has a dilemma: What to do with the runway?

Paved in the mid-1970s in the middle of a marsh full of alligators, the concrete strip—at 15,000 feet long and 300 feet wide, one of the world's most spacious—has been the end point for 61 of the 112 space shuttle missions flown successfully since 1981. Only rarely does the U.S. government lay open a valuable national asset like this. "We don't retire the space shuttle every day either," notes Jim Ball, Kennedy's spaceport development manager.

Late last summer NASA solicited expressions of interest from potential users. Officials said the request was the first step in deciding how and when to "expand access" to the capacity that's

### IN ORBIT

## Forecast: Hot and Sunny

Space shuttle *Discovery*, docked with the International Space Station, transits the sun on July 28, two days after the shuttle was launched on its first flight in two and a half years. Astronomer Anthony Ayiomamitis captured this image from his home in Athens, Greece. "It has been a serious chase for the past four years, trying to get this photo," he says. "My three earlier attempts failed due to the weather and a miscalibrated cellular phone, but I was fourth-time lucky." For more of his remarkable celestial imagery, visit [www.perseus.gr](http://www.perseus.gr).



ANTHONY AYIOMAMITIS



available at the facility known to astronauts as the SLF (Shuttle Landing Facility) and to pilots as X68, a three-letter/digit designator bestowed on airports by the Federal Aviation Administration. NASA expected to hear from other government agencies, academic organizations, aircraft manufacturers, and even a commercial spaceship developer or two.

Ball notes that it's NASA policy to find innovative applications for underused assets. "The alternative is to just lock the gate and let it deteriorate, and that doesn't help anybody," he says.

He declined to discuss proposed uses before all the responses were in, but pointed out that Piper Aircraft once used the runway to test a powerplant in one of its airplanes. That's an example NASA might deem a "reasonable fit" with the use of the SLF after the shuttle's last flight. Other uses the agency would support include launches of air-dropped space boosters, test flights of unmanned aerial vehicles and piloted space vehicles, and parabolic-arc tourist or research flights that simulate microgravity and serve as precursors to commercial space travel.

NASA plans to make the transition gradually, picking several projects as "pathfinders"—for policy development, price-setting, and coordination with the FAA and the Air Force, each of which has a say in SLF operations—before swinging the gate wide open. Some pathfinder projects could be implemented next year, the 30th anniversary of the runway's opening.

Other than the parabolic activity, NASA is ruling out commercial passenger flights and any other use that can be accommodated at a nearby airport. "We're not trying to steal their customers," says Ball. "Our intent is to have the runway be available to non-NASA users with a demonstrable reason to need its special characteristics"—length, width, and isolated location.

NASA may not be using the SLF much anymore, but the agency isn't ready to declare it excess property. It's looking for a long-term operator but has no plans to relinquish ownership. Who's to say the runway won't be needed somewhere down the road, perhaps for a fly-back vehicle associated with the U.S. moon-Mars exploration initiative? "It's not for sale, and 'lease' is probably too strong a word right now," says Ball.

—Beth Dickey

## Best in Show

**A** 1943 Piper L-4H owned by Colin and June Powers (below) of Monmouth, Oregon, flew off with the top honors at the National Aviation Heritage Invitational Eastern Region held during the Dayton Airshow in Ohio last July. Nicknamed the Grasshopper, the L-4



MIKE ULLERY

served as a liaison and artillery-spotter during World War II. A Grumman J24-F Duck belonging to Charles and Bev Greenhill of Mattawa, Illinois, waddled off with the Hap Arnold trophy for military aircraft as well as the People's Choice Award. The *City of Angels*, one of a pair of Piper PA-12 Super Cruisers that flew around the world in 1947, won the Paul E. Garber trophy for classic civilian aircraft. It was restored by Dave Liebegott and now belongs to Harry P. Mutter.

## Begging for Time

**L**ate last summer, the multibillion-dollar lenses of the Hubble Space Telescope, along with the infrared eyes of the Spitzer Space Telescope, were turned on what astronomers believe is Earth's newest solar system neighbor: a possible 10th planet, beyond Pluto.

Mike Brown of the California Institute of Technology discovered the yet-to-be-named planet last January with Chad Trujillo of the Gemini Observatory in Hawaii and David Rabinowitz of Yale University by using the 60-inch Samuel Oschin telescope tied to a 180-megapixel camera at Palomar, California. Brown, who also discovered the planetoid Sedna in 2004, says the team requested time on Hubble and Spitzer to confirm their findings.

"If somebody else out there had looked in the right place, then we would be reading about this in the newspapers right now," Brown says, "and our work would have been rewarding personally

but we would have missed out on the discovery."

However, by the end of this decade the great orbiting observatories might be fodder for history books, says astronomer and Hubble spokesman Ray Villard of the Space Telescope Science Institute in Baltimore, Maryland. Hubble is aging and suffers from balky gyroscopes. Spitzer was designed for a limited lifetime: Coolant that allows its infrared cameras to work will be nearly exhausted by 2008.

"I don't think people realize what will be lost when Hubble is gone," Villard says. "It's sad, but the great [astronomy] discoveries that hang on the walls of classrooms will not be followed for a long while, maybe more than a decade after Hubble is no longer in service."

Every year the institutes that govern Hubble and Spitzer solicit observation proposals. "There's always an imbalance," says Gordon Squires, an astronomer and spokesman for the Spitzer program, which is run by the Jet Propulsion Laboratory in California. "That's why we have an anonymous peer review, which passes judgment on what's worthy and

## IN MEMORIAM

**C**urtis Pitts, prolific aircraft designer and the father of the legendary Pitts Special, died in Homestead, Florida, last June from complications of heart surgery. He was 89.

Pitts built "The Special" in 1944 as a one-of-a-kind. The tiny biplane caused such a stir that it soon went into production and was the airplane *du jour* in aerobatic competitions for nearly two decades. *Little Stinker*, the second Special that Pitts custom-built, hangs in the National Air and Space Museum's Steven F. Udvar-Hazy Center in northern Virginia. Pitts conceived more than a dozen designs.

The Experimental Aircraft Association and the International Aerobatic Club partnered in creating a Curtis Pitts tribute at the annual EAA AirVenture fly-in, held in Oshkosh, Wisconsin, last July. Along with a number of Pitts' aircraft, the exhibit included a guest book, to be presented to the Pitts family, in which visitors were encouraged to write their recollections of the designer.

In the semi-circle around the tent are, starting at the left: Black-and-white S1C, red-and-white S1D, yellow-and-black first production-certified S1S, red-and-white prototype S1T, red-and-white S2A, black-and-white S2S, Model 12 prototype. Not visible (in tent) was the prototype S2 and a replica of the first S1 Pitts Special. Far left, visiting aircraft, starting at second from top: Three S2Bs, black-and-red Model 12, black-and-purple Model 12, blue-and-white S1C.



what can't be done during a cycle. Somebody is always disappointed."

For Hubble there are about 3,000 hours available per observation cycle; for Spitzer, almost 6,000. It may sound like a lot, but Villard says the time goes pretty quickly, considering it took Hubble more than 240 hours to make a spectacular deep-field survey of galaxies last year. Each telescope gets requests for more than 10,000 hours a cycle.

Earlier this year astronomers were told that the remaining observations for Hubble will be some of the most valuable time in the program's history. "We have to recognize Hubble has a limited lifespan, no matter what decisions are made concerning a rescue or other options," Villard says. "There are some really tough decisions to be made. One is whether to make many long observations of specific areas or to cut up the time into very short observations and cover a lot of areas."

However, astronomers have a back door to gain observation time. The Hubble and Spitzer science institute directors, Steven Beckwith and Thomas Soifer, are allocated about 300 hours per telescope for their discretion. The directors' personal time stash was used by Hubble to make the 10-day survey of galaxies. It's also how planet discoveries like Brown's are shoehorned into the observation schedule. "You have to beg, borrow or steal, but mostly

just beg, to get time," Brown says.

For the public, the planet stories are great reads during a commute, but for astronomers and scientists they can sometimes bring a sneer or a yawn. "What makes great observations in the public mind aren't always considered the best science," Villard says. "Mostly scientists like to use Hubble to look at what appear to be fuzzy white dots. That's great science, but not great photography."

Villard asked Hubble director Beckwith to part with some of his precious director's time for a historic 2003 shot at Mars. At 34.65 million miles, Mars was in opposition to Earth and the closest the Red Planet had been in almost 60,000 years. It won't be that close again for 282 years. "To me there are some observations you just have to make," says Villard. "Mars in 2003 was one of those."

For Brown, there is a larger balance to consider. A planetary scientist, he feels that not all planets need to be visited by robotic probes. Perhaps a trip to the Kuiper Belt or to Pluto would be better undertaken through the lenses of ground-based and orbiting observatories, unless something wondrous could be guaranteed on the other side, he says. "If we aren't going to learn enough to justify the cost of a mission, then that money is better spent elsewhere."

—Shelby G. Spires



JIM KOEPPICK

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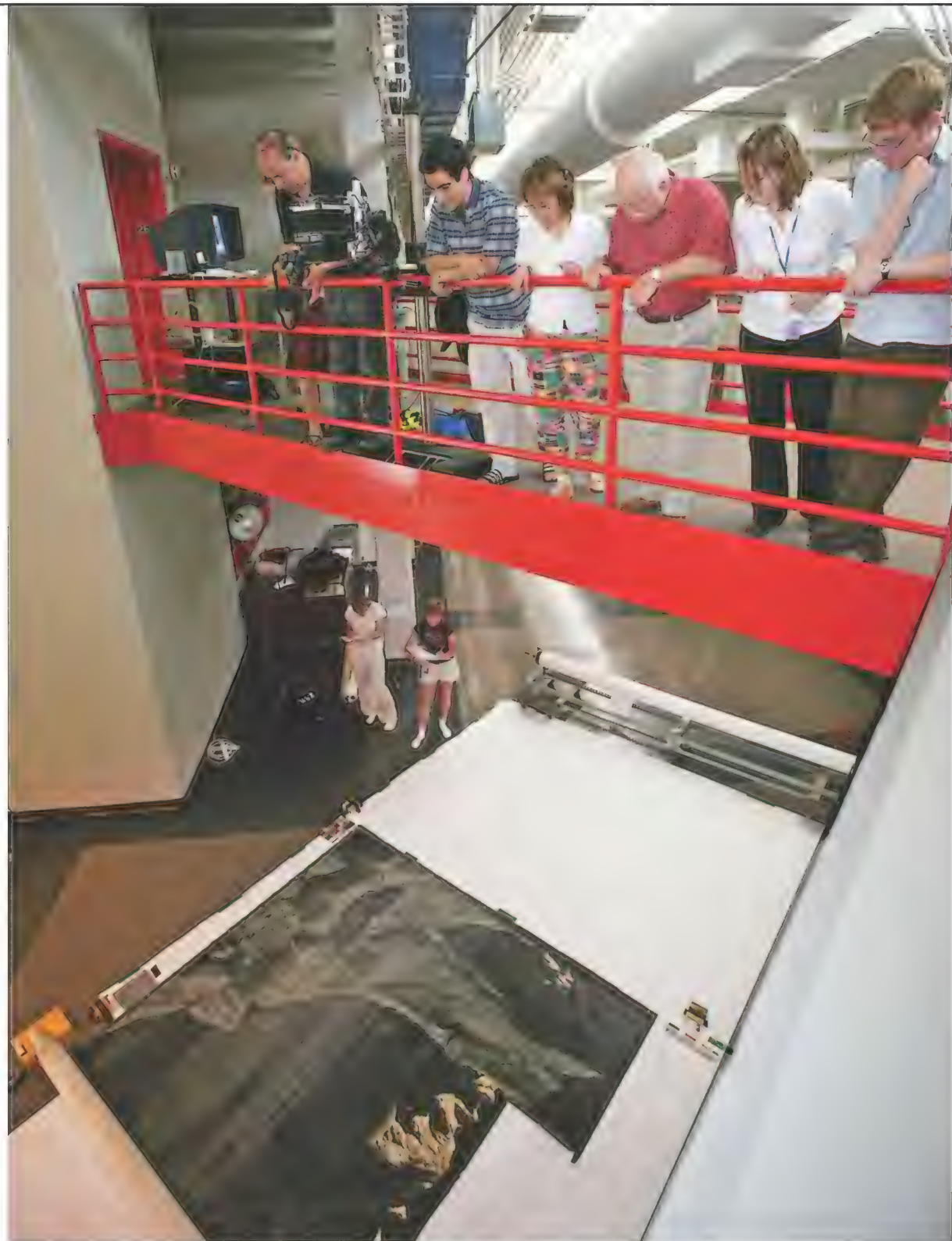


# History Unrolled

In 1956, Chesley Bonestell thought he knew what the moon looked like. That was the year the Museum of Science's Charles Hayden Planetarium in Boston commissioned him to paint a 10- by 40-foot mural of the lunar landscape. Bonestell had become known for his beautiful planetary and spaceflight illustrations, which were published during the 1940s and early 1950s in such magazines as *Life*, *Scientific American*, and *Collier's*. The first images of the moon (from the Soviet Union's Luna 3 probe) wouldn't be returned until 1959, so Bonestell began the oil-on-canvas mural with little information to go on. He portrayed the moon as a land of majestic mountains.

Bonestell spent a year working on "A Lunar Landscape," and in 1957, it was unveiled at the Charles Hayden Planetarium to much acclaim. But the mural fell out of favor after the Apollo 11 moon mission of July 1969, when Bonestell's dramatic landscape was contradicted by images of a barren world televised to Earth during Neil Armstrong's and Buzz Aldrin's moonwalks. Bradford Washburn, founder of the Museum of Science in Boston, promptly ordered "A Lunar Landscape" put into storage.

In 1976, the National Air and Space Museum opened in a brand-new building on the National Mall, and Fred Durant, then the Museum's assistant director of astronautics, was looking to start a collection of space art. He had long admired the work of his friend Bonestell, and when he and his staff inquired about obtaining "A Lunar Landscape," the Charles Hayden Planetarium had no qualms about donating the fanciful mural. In a letter that Bonestell wrote to Durant on May 20, 1976, the artist inquired good-naturedly about the fate of the mural: "I sort of consider [the mural] one of my 'children' and, like any parent, would like to know where this particular



ERIC LONG

child is living now! Perhaps he's just rolled up sleeping in a storage room somewhere—if so I don't mind, I'd just like to know."

It was Durant's dream to hang the three-panel mural in the Museum, but it had been damaged during its removal from display at the Charles Hayden Planetarium. Since the Museum did not then have the funds to refurbish such a large work of art, the painting was rolled up and put into storage at the Museum Support Center in Suitland, Maryland.

Almost 30 years later, "A Lunar Landscape" has found a new group of admirers, many of whom gathered at the Suitland center on July 12 to watch the mural be unrolled after 29 years in storage. The gathering of space art enthusiasts, museum curators, and art conservators included Ron Miller, the author of two books on Bonestell and co-administrator of Bonestell Space Art,

After 29 years in storage, Chesley Bonestell's mural of the moon requires restoration. Smithsonian staff were on hand for the July 12 unrolling.

which controls the use of the artist's work. "I grew up on his space art when I was a kid, and his work was a major influence on me," says Miller, a space artist whose work has been published in this magazine.

Aeronautics curator Tom Crouch, who oversees the Museum's art collection, also has childhood memories of Bonestell's work. "I still have the copy of the book, *Conquest of the Moon*, illustrated by Bonestell and others, that my parents gave me on my 11th birthday," he says.

"Thomas Moran, Albert Bierstadt, William Henry Holmes, and other artists mixed science with artistic vision to produce images that introduced 19th



century Americans to the scenic wonders of the American west," says Crouch. "Chesley Bonestell employed the same mix of talent and imagination to show us what it would be like to stand on the surface of other worlds."

Durant, 88 and now retired, eventually became an agent for Bonestell, and was pleased to hear about the mural's unrolling, though he did not attend the event. "I consider that mural an icon because it represents a view of the future of spaceflight before it became possible," says Durant. "That's his legacy in that painting." In an interview published in the May-June 1977 issue of the *Astronomical Society of the Pacific's* magazine *Mercury*, the artist, who died in 1986, said: "In the case of the moon I made some bad mistakes. I should have realized that the moon, without any atmosphere, must have been just beaten to smithereens by the constant bombardment from four billion years of meteors dropping on it."

Among the art enthusiasts at the unrolling were Jia-Sun Tsang, the center's senior painting conservator, and her team. They, along with Museum conservator Ed McManus, were the first ones to assess what needs to be restored

on the mural, which overall is in good condition. As expected, some of the paint has flaked off, and much of the painting is covered with a layer of powder, what Tsang refers to as "white bloom." Tsang believes the bloom developed when zinc from the mural's primer layer and the paint reacted with moisture. "Restoration of this work will be a monumental undertaking," says Greg Bryant of the Museum's registrar office.

Tsang and her team are recommending several techniques for the restoration, including exfoliating the bloom with a conservation-grade sponge and employing a process called "inpainting," which would brighten the mural's images with touches of fresh paint. Whatever techniques are used, Tsang would like to see the mural's three panels placed on stretchers to flatten them, then conserved with a light spray of varnish.

Tom Crouch plans on looking into having the mural, once restored, put on display at the Museum's Steven F. Udvar-Hazy Center in Chantilly, Virginia.

When asked how he feels about the mural he collected in 1976 being restored, Fred Durant has only one word: "Ecstatic."

—Allie Hagerman



## VISITOR INFORMATION

**October 4** General Electric Aviation Lecture: "An Evening With Chuck Yeager." The renowned test pilot will share memories of his climb from enlisted man in the U.S. Army Air Corps to brigadier general. Free tickets may be obtained online through [www.nasm.si.edu](http://www.nasm.si.edu); for more information, call (202) 633-2398. Lockheed Martin IMAX Theater, 8 p.m.

**October 8** Saturday Star Party. Join National Air and Space Museum staff astronomer Sean O'Brien to observe celestial objects in dark skies unpolluted by city lights. The evening begins with a short orientation of the night sky. Sky Meadows State Park, near Paris, Virginia, 5 p.m. to 11 p.m. Parking fee: \$4 per car; park phone number: (540) 592-3556.

### Curator's Choice

Occasionally a National Air and Space Museum curator gives a 15-minute talk about an artifact or subject of interest at the Steven F. Udvar-Hazy Center. Meet at the nose of the SR-71 Blackbird reconnaissance aircraft at noon. Oct. 6, Charles Lindbergh and Popular Culture; Oct. 20, Goddard's 1936 rocket; Nov. 3, Concorde and the Failure of Supersonic Transport; Nov. 17, Space Shuttle Launch-Entry Suit.

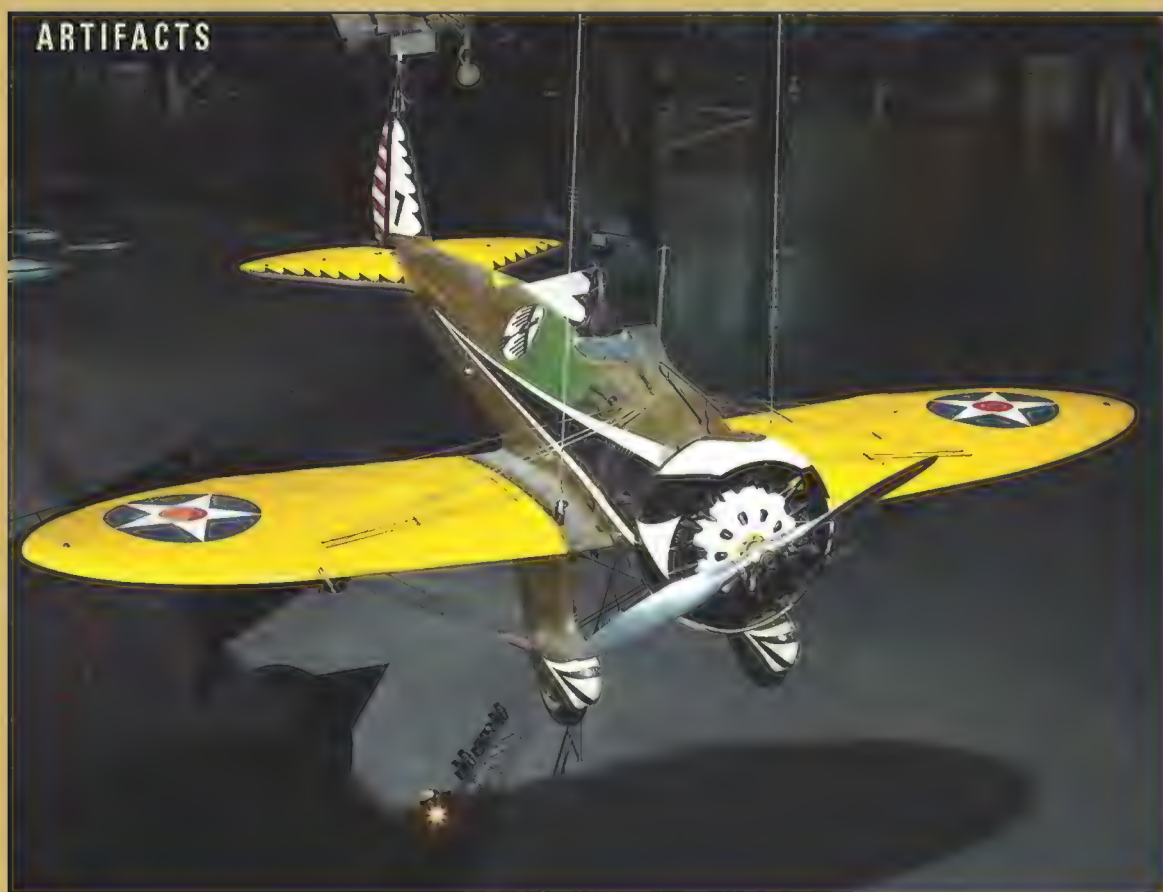
*Except where noted, no tickets or reservations are required. To find out more, visit [www.nasm.si.edu](http://www.nasm.si.edu) or call Smithsonian Information at (202) 357-2700; TTY: (202) 357-1729.*

**Location** The National Air and Space Museum is on the National Mall, along Independence Avenue SW, between 4th and 7th Streets, Washington, D.C. The Steven F. Udvar-Hazy Center is at 14390 Air and Space Museum Parkway, Chantilly, Virginia.

**Hours** The Museum on the Mall and the Udvar-Hazy Center are open from 10 a.m. to 5:30 p.m. every day except December 25.

**Shopping** Both the Museum and the Udvar-Hazy Center shops offer a variety of souvenirs, books, DVDs, models, posters, clothing, and toys. A selection of these products can be purchased online at [SmithsonianStore.com](http://SmithsonianStore.com).

**NASM Express Shuttle Bus** A round-trip shuttle runs between the Museum and the Udvar-Hazy Center from 9 a.m. to 5 p.m. Since the \$12 round-trip tickets sell out quickly, visitors are encouraged to purchase them in advance at (202) 633-4629; toll-free (877) 932-4629.



DANE PENLAND

In the mid-1930s, the Boeing P-26 "Peashooter" served as a fighter for the U.S. Army Air Corps. Boeing's designers broke new ground with the P-26, discarding wood-and-fabric biplane designs for a sleek, all-metal monoplane. Still, the P-26 had its predecessors' open cockpit, fixed landing gear, and external wing bracing. The Museum's P-26, an A model, was stationed with the Panama Canal air force (a branch of the U.S. Army Air Corps) before being given to Guatemala in 1942, where it flew with the Guatemalan air force from 1943 to 1954. In 1957, the government of Guatemala donated the Peashooter to the Smithsonian Institution, and the U.S. Air Force restored the fighter, painting it in the colors of the 34th Attack Squadron.



# A Wartime Romance

Taking a few days off after a business trip several years ago, I visited the area surrounding Debden Airfield in Essex, England, in an attempt to deepen my understanding of the U.S. Fourth Fighter Group, which had been based there during World War II as part of the massive Eighth Air Force.

I've been fascinated with these pilots since I was old enough to own my first library card. Back then, in the 1950s, the pilots' story was still recent news. The Fourth descended from the group of U.S. pilots who first volunteered to fly for England's Royal Air Force before the United States entered the war. Many of them were ultimately assembled into what were called the Eagle Squadrons, following in the footsteps of the World War I Lafayette Escadrille, U.S. pilots who had flown for France. The Eagles flew fighters—Spitfires and Hurricanes—and wore the uniform of the RAF with an "ES" patch on the shoulder. Along with the uniforms, the young American adventurers also donned much of the RAF's casual attitude toward military discipline. They tended to wear their hair long and took an individualist's approach to military dress and custom.

After Pearl Harbor, the Eagles were inducted into the U.S. Army Air Forces and consolidated at Debden, an RAF base in Essex, 10 miles south of Cambridge. They

brought with them many RAF-like habits, which didn't always sit well with the American command structure. Still, no one could argue with their success. The Fourth destroyed more German aircraft than any other U.S. group in the war.

Along with the pilots, a veritable cast of thousands was needed every day to launch three squadrons of 16-plus P-51 Mustangs, which often flew to Berlin and back. The United States sent to England mechanics, sheet metal repairmen, armorers, radar operators, meteorologists, parachute riggers, cooks, and, of course, an army of clerks to keep the red tape unrolling. I'd read that throughout England, the citizens harbored mixed feelings about the swarm of Americans occupying their sceptered isle. Though grateful that the Yanks had helped stymie Hitler's plans for a Nazi invasion, workaday Brits simultaneously resented the American hordes for being "overpaid, oversexed, and over here."

One of the intelligence officers at Debden, Grover Hall, was a newspaperman from Alabama with an eye and ear for the human side of his corner of the war. He wrote a book about the Fourth, *One Thousand Destroyed: The Life and Times of the Fourth Fighter Group* (look for used copies on Amazon.com or eBay), that offers insight into the day-to-day lives of many of the Fourth's personalities.

The book recounts that when the young fighter pilots weren't escorting bombers over Europe or strafing Luftwaffe aerodromes lined with anti-aircraft batteries, they were often in the pubs in the town of Saffron Walden, about two miles from the airfield. Nearby was Debden village, a grouping of 30 or so thatched-roof houses and shops. The village's pub, The Plough, was popular among the enlisted men, who, unlike the pilots, couldn't commandeer a car for a ride into Saffron Walden, which had more upscale drinking establishments.

At one of the pubs in Saffron Walden, I ordered a pint of bitter and asked a local gentleman farmer if he was aware of the role Debden played in aviation history. He was, and because the town isn't exactly on the tourist track, an American in a pub asking about local history caused a bit of a stir. The farmer introduced me to a few other patrons, and after more socializing, one of them said, "You really ought to meet Jimmy over at Debden village. His father was an American." The others nodded.

"I guess some of our guys did marry their English girlfriends," I said. Awkward silence ensued, accompanied by some staring at shoes. So I added, "and I guess some of them didn't."

Eventually, the villagers told me that Jimmy's dad, a sergeant assigned to an aircraft maintenance unit in the Fourth,



HARRY WHITVER



met Jimmy's mom at The Plough, and they had been together for more than two years before the baby came along. "He would walk along in town with her, pushing the pram with little Jimmy, just as proud as any other dad," they said.

The next day at noon, equipped with another pint, I was sitting in The Plough with a handful of regulars. The pub was quiet at lunchtime, and I asked the bartender if he knew Jimmy. He looked me over with a "Who wants to know?"

## The Plough was popular among the enlisted men, who, unlike the pilots, couldn't commandeer a car for a ride into Saffron Walden, which had more upscale drinking establishments.

expression, then craned his neck to look out the front window. He resumed mopping the bar with a towel and said, "He was playing golf this morning, but I see his car's there in the drive." Then he looked up and grinned. "His wife's sister's visiting, so with two women in the house, he'll probably be over here presently."

True to the bartender's prediction, 15 minutes hadn't passed before a trim, salt-and-pepper-haired 55-year-old walked into the room, squinting a bit as his eyes adjusted from the bright sunlight. He was tanned and wearing Bermudas and a golf shirt, and he quickly acquired a pint mug.

The bartender gestured in my direction. "Hey, Jimmy," he said, "Yank over here is interested in goings-on during the war."

"Oh yeah?" Jimmy said with a wry smile. "Well, I'm a product of that."

And so he was. Everyone there knew the story, of course, and he was quite comfortable sharing it matter-of-factly with a stranger as we stood finishing our pints; then he bought me a second. "I'll take you on a walk and show you the tree where I was conceived, if you like," he said. Everyone laughed.

I declined the tour, but when he offered to introduce me to his mother, I jumped at the chance. I had assumed that she wasn't still with us, but she was, very much so. Some of the others in the pub rolled their eyes a bit, and one said, "Oh, Nora'll talk, all right. All afternoon

and into the night if you like."

Jimmy called her on his cell phone, then directed me to her house, a couple doors down from the pub. Everywhere in Debden village seems to be a couple doors down from the pub.

Her house was behind a low picket fence surrounding a garden of rose bushes. I knocked and Jimmy's mom answered and showed me into her house, a cottage by American standards. It was as neat and sunny as the garden.

Short, slight, and gray, Nora still showed a glint of the saucy, adventurous young woman she would have been during the war. She offered me tea and settled into her sofa to answer my questions.

It turns out "Jimmy's dad," as she consistently referred to him, was reassigned at war's end and abruptly swept out of Debden as part of the whirlwind of troop movements that followed Victory in Europe Day. At first, she said, he wrote every day from his barracks somewhere else in England as he waited to be sent home. As time went on, however, the letters came less frequently, then stopped altogether some time after he shipped out. Much later, she married a local man who helped her raise her son. Widowed for many years when I met her, Nora kept a wartime picture of Jimmy's dad in his uniform on a living room cabinet, but there were no pictures of her husband.

Jimmy had told me that in 1984, when he turned 40, he had looked up his father in the States and contacted him. His dad had gone on to a career as a police officer and, later, a prison guard in Phoenix, Arizona. Jimmy wasn't particularly forthcoming as to how his father had reacted to that first phone call, and I couldn't help wondering what that must have been like for both of them. Jimmy arranged to travel to Phoenix to meet him. Three weeks before the planned encounter, however, the former aircraft repairman died

suddenly of a heart attack.

Jimmy used his airplane ticket to Phoenix to attend the funeral. He told me, "It really wasn't the way I'd planned it, but the first time I saw my dad, he was in a box."

After Nora and I had talked a bit, I risked breaching etiquette and asked her if she had had the chance to speak to her former sweetheart after all those years.

"Oh yes!" she said. "He rang me up many times and we would just talk and talk. After all those years. Think of it!"

"He told me he was afraid he wouldn't live up to Jimmy's expectations, and I said, 'Of course you will...of course you will.' I was widowed by then. He told me he'd come over here for a visit in October—but then, he died in April." She paused and brushed a tissue at her nose. "But he died in April," she repeated quietly, looking up absently at the pale blue ceiling. Then, quickly snapping on a brave, polite smile, she said softly, "Oh, we all got older, didn't we? Some things in life just weren't meant to be, I guess."

I chatted with Nora for about two hours about her wartime life, her friends, and, of course, how proud she was of her only son. Then I left, but she made me promise to stop in the next time I visited Debden village.

Two years later, I attended a reunion of the Fourth Fighter Group in Savannah, Georgia. Among the veterans was another former mechanic and his wife, who still spoke with a cultured British accent after five decades living in the United States. Unlike Jimmy's father, this man did marry his wartime sweetheart and brought her home with him. They delighted in retelling how they met one warm summer's evening on the narrow lanes of Debden village, and how she tricked him into going for a walk with her rather than to a party at The Plough.

Almost as an afterthought, I asked if she knew Nora. "Oh, my God!" she gasped. "You know Nora?" I told her my story as she fought back tears, while simultaneously laughing at the memories of one of her closest childhood friends. "We were so young," she said, several times. "And Nora was such fun in those days."

"She still is," I said.

—Mark Phelps



SOURCE: AERONAUTICAL INFORMATION MANUAL/FEDERAL AIR REGULATIONS

SECTION 3 - AIRPORT OPERATIONS

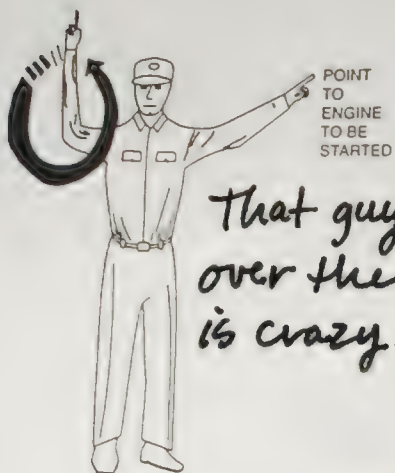


Figure 4-3-8. Start Engine

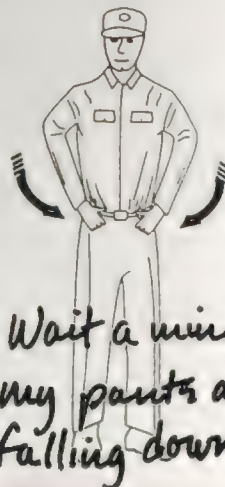


Figure 4-3-15. Insert Chocks

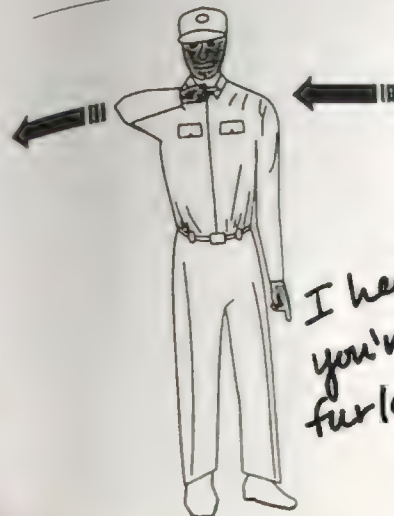


Figure 4-3-16. Cut Engines

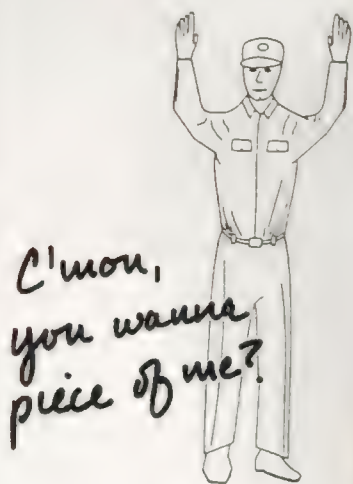


Figure 4-3-14. Stop

Para. 4-3-25

SECTION 3 - AIRPORT OPERATIONS

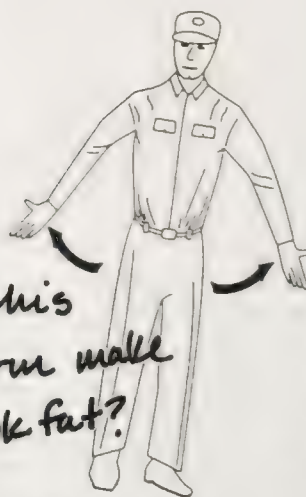


Figure 4-3-9. Pull Chocks

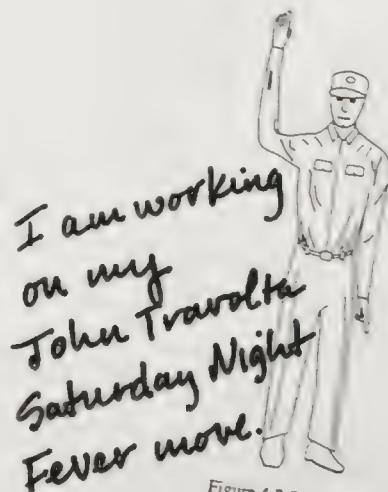
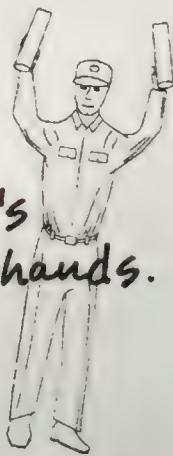


Figure 4-3-7. All Clear



(Uses same hand movements as day operation)  
Figure 4-3-17. Night Operation



Figure 4-3-18. Emergency Stop

## Sign Language

**"H**and Signals," found in the Aeronautical Information Manual/Federal Air Regulations, are used by ground personnel to direct airliners, primarily to a terminal where the engines are shut down and passengers are offloaded. *Air & Space* has taken the liberty of providing alternate translations.

—Patricia Trenner



To some, sunglasses are a fashion accessory...

# But When Driving, These Sunglasses May Save Your Life!

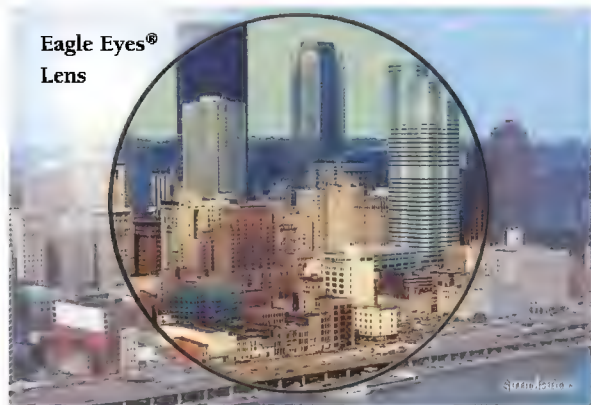
**Drivers Alert:** The sun is at its most dangerous position in the autumn months, creating difficult driving conditions at rush hour.

**D**angerous glare is at maximum levels when the sun is low in the sky. In the fall, this glare is at its worst at afternoon and morning rush hours—your peak driving times. Do you know how to protect yourself? An amazing breakthrough in optic technology by NASA called Eagle Eyes® can be your answer. The Eagle Eyes lens technology can actually eliminate blinding glare and harmful UV rays.

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## Beware of windshield glare!

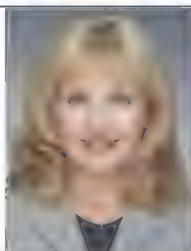
This glare-induced "blindness" is especially prevalent in the early morning or late in the afternoon, and due to the extremely reflective qualities of other cars. Even your windshield can make matters worse since wax and oil build up can increase reflected glare. This powerful glare of the sun can be damaging to the various layers of the eye. Certain road conditions can actually raise the amount of UV that you are exposed to by up to 85%.



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## NASA's researchers looked to nature for a solution.

Conventional sunglasses can in fact blur your vision by allowing harmful UV, blue light rays, and reflective glare in. They can also darken useful, vision-enhancing light rays. At NASA's Jet Propulsion Laboratory scientists looked to nature for a solution by studying the eyes of eagles, known for their extreme visual acuity. The result of this breakthrough optical technology is Eagle Eyes®. NASA's researchers studied how eagles can simultaneously distinguish their prey from their surroundings with utmost precision, while protecting their eyes from the daily exposure of harmful high-energy sunlight. These studies led to revolutionary protection for human eyesight.

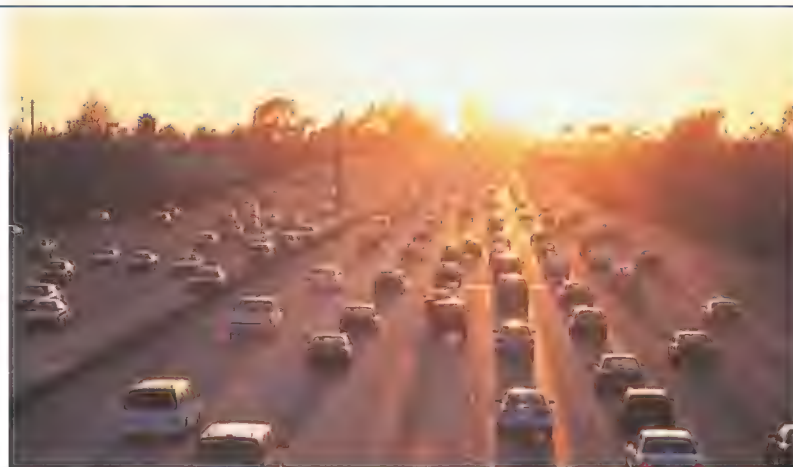
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\*Eagle Eyes are patented, officially recognized NASA Spinoff technology and are on display at NASA's Houston Space Visitors Center.

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# THE LITTLE ENGINE

THAT COULDN'T

**I**T'S AUGUST 26, 2002, a clear, hot morning at Albuquerque International Sunport. Poised for takeoff on Runway 17 is a small orange and white twin-engine jet carrying a heavy load of hype and hope. A press release from its manufacturer says the first flight of this prototype will do nothing less than "forever change the landscape of transportation." The Eclipse 500's promised \$837,500 price tag—an astonishingly low figure, barely a quarter that of the next cheapest jet—and 56-cents-a-mile direct operating cost have brought in deposits for more than 2,000 airplanes, potentially making it the best-selling private jet in history even before it flies.

Two engine nacelles, stovepipe-skinny and barely four feet long, sprout from the rear fuselage. They hold the key to the Eclipse's remarkable price and performance claims: a pair of Williams International EJ22 fanjets, breakthrough powerplants developed by Sam Williams, the renowned guru of small jet engines. Using what Eclipse calls "disruptive" technology, the EJ22 has churned out 770 pounds of thrust in ground tests, yet, at 85 pounds, you could pick it up. This 9:1 thrust-to-

weight ratio is unprecedented, almost double that of any commercial jet engine. It's the breakthrough that can make the Eclipse 500 a landscape changer.

Albuquerque Tower clears N500EA for takeoff, and test pilot Bill Bubb releases the brakes and shoves the twin thrust levers forward. The EJ22s spool up into a soft *whoosh* and the airplane begins to accelerate down the runway.

But something's wrong. The acceleration is lethargic, especially for an airplane loaded so lightly. In the hot, thin, mile-high air, the EJ22s can generate barely half their rated thrust. After a leisurely takeoff roll of more than 3,000 feet, the airplane lifts off and begins a gentle climb, paralleling the Sangre de Cristo mountains off its left wing. For about an hour, Bubb flies the planned test routine, checking out general handling qualities and systems operation. Overall, the flight is free of major glitches.

And yet, as the little jet taxis back toward the cheering employees at the

What came between the Williams International EJ22 and the Eclipse 500 lightjet?

by David Noland



Eclipse hangar, it's already clear that the new EJ22 engines aren't going to hack it.

**T**he Eclipse 500 never again flew with EJ22s. Three months later, Eclipse Aviation announced: "The EJ22 is not a viable solution for the Eclipse 500 aircraft, and Williams International has not met its contractual obligations." Williams conceded that it had run into "a number of challenges" with the EJ22 but insisted it had satisfied the contract, implying that the airplane had simply grown too heavy.

Eclipse hurriedly signed a deal with Pratt & Whitney to develop a smaller version of a more conventional engine. The PW610F would develop 900 pounds of thrust, but it would weigh 260 pounds—triple the weight of the EJ22. The

*Sam Williams (left) envisioned a small engine that would power a generation of very light jets, like the Eclipse 500 (below, landing after its first flight with the EJ22).*

BELOW: COURTESY ECLIPSE AVIATION; LEFT: © DWIGHT CENDROWSKI







A WR19 turbofan powered the WASP II flying platform.

Cessna's T-37 (above) was dubbed "Tweety Bird" for its shrill Teledyne CAE J-69s. Its CitationJet (right) flies with whisper-soft FJ44s.



In the 1970s, Tony Fox (left, with a pair of torso-mounted Williams WR44s), hyped the very light Foxjet.

extra power would give the Eclipse 500 a bit better speed and climb, but there was a big downside: an empty-weight gain of 700 pounds and a 20 percent increase in fuel consumption. The remarkable price and cost projections eventually ballooned to \$1.3 million and 89 cents a mile. Three years later, flight tests of the P&W-powered Eclipse 500 are proceeding smoothly, but it's still not clear whether it will change the landscape of transportation.

The failure of the Williams EJ22 to achieve Federal Aviation Administration certification in the Eclipse and the engine's disappearance from public view were bitter disappointments to

those who for decades have yearned for a certified engine that could lead to a new generation of small, affordable jets. The failure was also a blow to the reputation of its creator, Sam Williams, now 84, who essentially invented the small turbofan engine in the 1960s and remained its unchallenged mastermind for more than three decades.

Williams wasn't the first to build a tiny jet engine. Back in the early 1950s, the French-built Turboméca Palas, with 330 pounds of thrust, inspired the creation of half a dozen oddball experimental Euro mini-jets. The Palas grew into the Marboré series (660 to 1,058 pounds of thrust), which powered a number of small military jets, such as the Morane-Saulnier 760 Paris four-seater and Cessna T-37 trainer. (The latter used the J-69, a version of the

Marboré made by the U.S. company Teledyne CAE.) In the 1970s, the French firm Microturbo lowered the bar with the 220-pound-thrust TRS 18, which flew in the Italian Caproni A21J sailplane and in U.S. designer Jim Bede's BD-5J airshow jet. Only 24 inches long, the TRS 18 is still the smallest jet engine ever to power a manned aircraft.

Those early mini-engines had a problem, though. Like all turbojets, they sucked up prodigious amounts of fuel. Worse, small aircraft are penalized by the pitiless exponential mathematics of scaling down: Reduce an airplane's length by half, and internal volume for fuel shrinks eightfold. The BD-5J had an endurance of about an hour or so and a range of around 300 miles.

To be commercially viable, a small jet engine had to be fuel-efficient. That meant it had to be a turbofan. While Pratt & Whitney and Rolls-Royce began pushing ahead with turbofan technology in large engines in the 1960s, it



was left to a young Purdue graduate and former Chrysler engineer named Sam Williams to create a small, fuel-efficient turbofan.

Williams left Chrysler in 1954 to start his own company. His first jet engine, prosaically named Jet No. 1, made its first run in 1957 at a meager 60 pounds of thrust. It weighed just 23 pounds; an old Williams publicity photo showed a smiling June Cleaver lookalike holding it in one hand. An improved version, the WR2, ran in 1962. Hewing closely to Frank Whittle's 1930 turbojet configuration, the WR2 had a single-stage centrifugal compressor and a single-stage turbine. The reference book *Jane's All the World's Aircraft* described the engine as "simple in design, almost to the point of appearing crude." In 1964, a more powerful version of the WR2 became the first Williams jet to fly, powering the Canadair CL-89 reconnaissance drone. The follow-on WR24 series, despite horrendous fuel consumption, was Williams' first big commercial success, eventually powering more than 6,000 short-range Northrop target drones.

In 1967, Williams completed its breakthrough engine. The WR19, a turbofan based on the WR2 core, produced 430 pounds of thrust, weighed only 67 pounds, and was nearly twice as fuel-

efficient as the WR2. It powered two short-lived 1970s contraptions: the Bell Jet Flying Belt, a Buzz Lightyear-style jet backpack; and the WASP II flying platform, a sort of aerial Segway Human Transporter.

The WR19 also caught the eye of military planners studying the concept of a long-range cruise missile. Williams' timing was perfect; the WR19 was the only small engine with the fuel efficiency the cruise missile mission demanded. An up-rated version of the WR19, the 600-pound-thrust F107, eventually became the prime mover for the Navy Tomahawk and Air Force Air-Launched Cruise Missile, with production of more than 6,500 engines over 30 years. For creating the F107, Williams was awarded aviation's highest honor, the Collier Trophy, in 1979.

Williams had begun tinkering with a small civilian turbofan based on his cruise missile technology as far back as 1971. But it would be a huge step to take a specialized Tomahawk powerplant, which only had to start once and run for three or four hours, and adapt the technology to produce a commercially viable engine.

Small size itself creates many design problems. Turbine blades can be made smaller, but air molecules can't; as a result, skin friction and boundary lay-

er effects are proportionally greater. (In engineering argot, a small engine is inherently less efficient because it operates at a low Reynolds number, an aerodynamic coefficient that relates component size to the air's inertial and viscosity effects.) Compressor and turbine blade tip clearances are proportionally greater, resulting in greater tip losses. To maintain the most efficient turbine and compressor blade tip speeds, small engines must spin faster. Small turbine blades are also harder to cool. Oil passages become narrower, making lubrication tricky. Manufacturing tolerances shrink to watchmaker scale.

In 1978 Williams signed a deal to develop the WR44, an engine with 850 pounds of thrust for the five-passenger Foxjet 600, an aircraft eerily similar to the Eclipse but doomed to mock-up status. A subsequent flirtation with the ill-fated American Jet Industries Hustler likewise went nowhere, and it wasn't until 1988 that a Williams engine finally took wing with a human aboard. A pair of 1,800-pound-thrust FJ44s powered Burt Rutan's Triumph, a proof-of-concept prototype for a Beech light business jet.

It was Cessna that jumped on the light-jet concept, however, and in 1992 the Cessna CitationJet, with a pair of FAA-certified FJ-44-1As, rated at 1,900

## Compressors

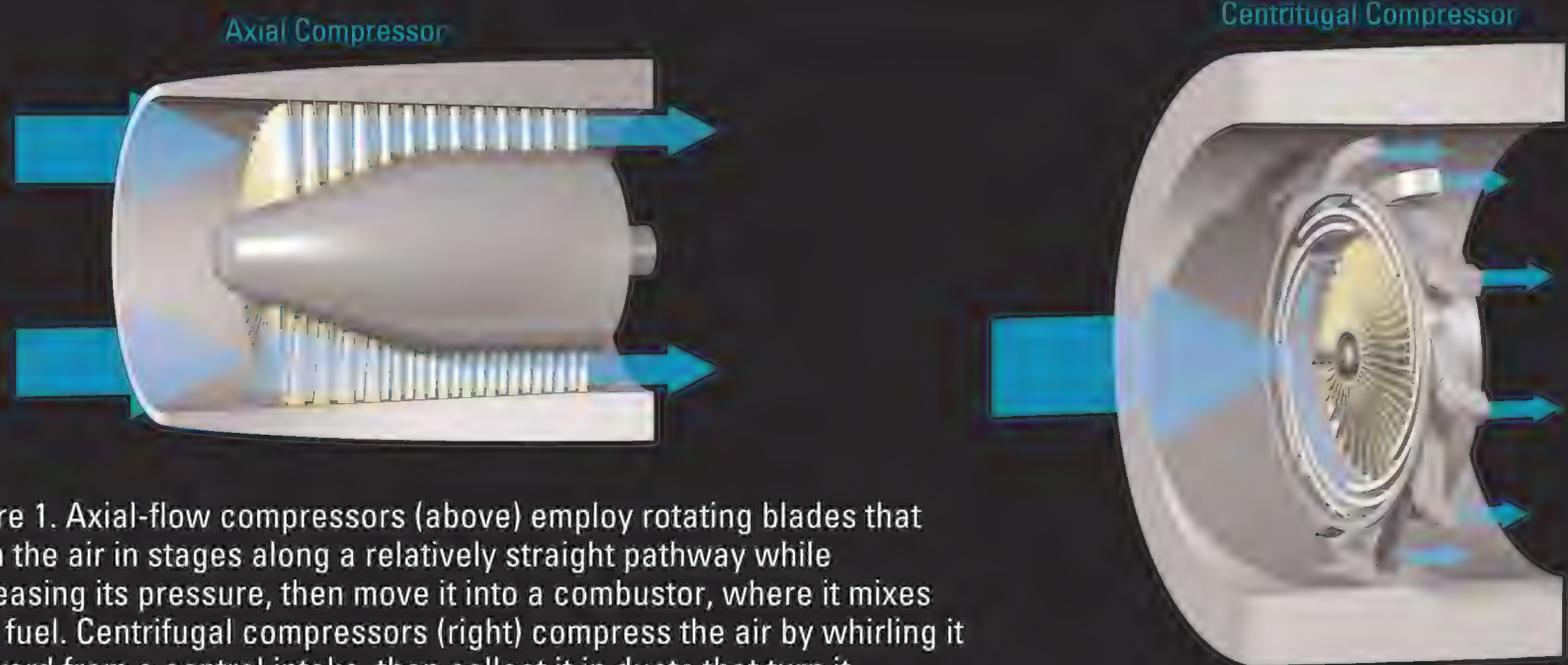


Figure 1. Axial-flow compressors (above) employ rotating blades that push the air in stages along a relatively straight pathway while increasing its pressure, then move it into a combustor, where it mixes with fuel. Centrifugal compressors (right) compress the air by whirling it outward from a central intake, then collect it in ducts that turn it 90 degrees on its way to mix with fuel in the combustors.

ILLUSTRATIONS BY JOHN MACNEILL



pounds of thrust and weighing 450 pounds, became the first production aircraft with Williams engines. At a bargain \$3.2 million, it quickly became the best selling bizjet in history. Once again, Williams had jump-started a whole new class of aircraft, and once again he had the niche to himself.

**B**ut the elusive Foxjet category still beckoned. In the early 1990s, Williams began developing a fan-jet in the 700-pound-thrust class. The new engine would be a clean break from the philosophy of gradual evolution and refinement that had guided the 35-year progression from Jet No. 1 to the FJ44. Developing this new technology would be expensive, but again Williams' timing was impeccable. The General Aviation Propulsion (GAP) initiative, a pet program of NASA Administrator Dan Goldin, promised to revitalize the moribund lightplane industry with innovative engine technology. In 1996 Williams teamed up with NASA for a four-year, \$100 million effort to "reduce the cost of small turbine engines by a factor of ten and revolutionize the concept of personal air transportation," as a NASA press release put it.

When NASA engineers first saw Williams' radical new GAP design, the FJX-2, they were skeptical. "We weren't sure if they could really do this," recalls Leo Burkardt, the GAP program manager. "Their projected performance, weight, and cost were so much better than the other proposals that even if they only got halfway there, it would still be better than anybody else."

John Adamczyk, the NASA senior technologist on the project, still remembers his shock upon first seeing the FJX-2's parts laid out. "I just shook my head in amazement at how small it all was. It looked like someone was assembling a Swiss watch." A five-stage compressor from the FJX-2 that Williams showed off at the 1997 Oshkosh, Wisconsin airshow looked more like the business end of a Cuisinart than the seeds of an aeronautical revolution. With each stage intricately carved from a single piece of titanium, it weighed one pound, three ounces. "You could hold it in the palm of your hand," recalls Adamczyk, still awestruck.

But the doubts vanished a year or so into the program, after the first test of the main compressor. "All the numbers matched our analysis," remembers Adamczyk. "It really gelled at that

point." The complete engine first ran in August 1999 and was soon hitting its predicted thrust numbers. Four engines eventually accumulated a total of almost 900 starts and more than 500 hours of running time in the test cell. Testifying before Congress in 2000, Sam Williams declared the FJX-2 a "major success." Adamczyk, a 30-year veteran who has worked on numerous jet engine projects, calls the FJX-2 "one of the high points of my career."

All the while, Williams had been promoting the concept of a very light jet (VLJ) that could eventually use his new engine. In 1996, he'd hired Burt Rutan to build a demonstrator aircraft, the four-seat V-Jet II. Williams' contract with NASA called for the V-Jet II to fly with a pair of FJX-2s as the capstone to the GAP project. But it initially flew with FJX-1s, man-rated versions of the F107 cruise missile engine rated at 550 pounds of thrust. With Goldin in attendance, the V-Jet II created a sensation at Oshkosh in 1997 with the noisy, underpowered FJX-1s. Among the thousands of salivating airplane buffs in the audience was a wealthy pilot and businessman named Vern Raburn.

An early Microsoft executive and stockholder, Raburn had just left a job overseeing the technology investments of billionaire Microsoft co-founder Paul Allen, for whom he jetted around the country at the controls of a Williams-powered CitationJet. Raburn had the restless soul of an entrepreneur, and he had long nurtured the same vision as Williams: a small, inexpensive jet airplane. Galvanized by the V-Jet II and reports of the extraordinary little FJX-2, Raburn signed a deal with Williams in May 1998 to jointly develop a five- or six-seat VLJ. It would be powered by an FAA-certified version of the FJX-2, to be called the EJ22. Together, Sam Williams and Vern Raburn were going to revolutionize aviation.

With \$60 million in investors' money, a board of directors studded with

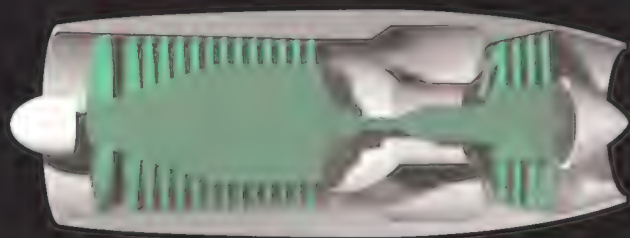
*Eclipse Aviation CEO Vern Raburn shared the spotlight in his firm's tent at Oshkosh this summer with a giant-screen projection of his lightjet, now in flight test and scheduled to receive FAA certification next March.*



CAROLINE SHEEN



## Spools



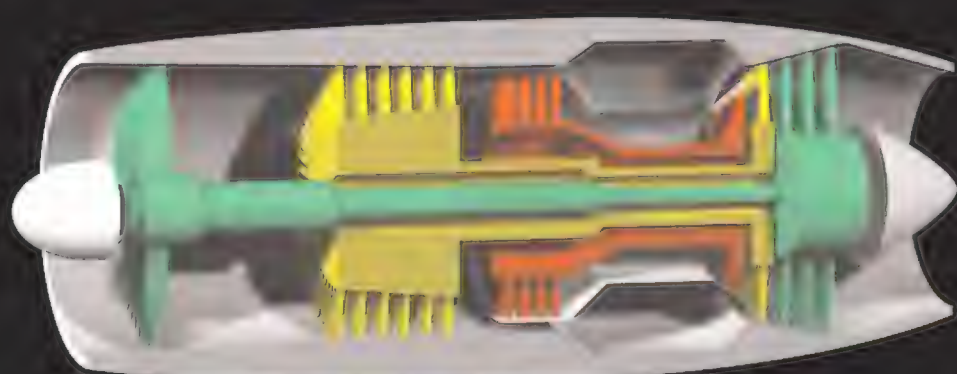
Single-Spool Engine



Two-Spool Engine

Figure 2. Turbojet engines compress air, mix fuel with the compressed air, burn the mixture, and capture some of the energy of the exhaust gases with turbines as the jet exhaust exits and produces thrust. Turbines drive the compressors through

shafts that connect the two. High-pressure turbines and compressors (yellow) boost the efficiency of the engine. They spin at higher speeds and experience higher temperatures than the low-pressure sections (green). A third spool (red) provides additional efficiency by offering a different set of rotational speeds and temperatures but creates a complex structure of seals and bearings.



Three-Spool Engine

ILLUSTRATIONS BY JOHN MACNEILL

*The airplane that launched a thousand jets: Williams seduced lightjet lovers with the Burt Rutan-built V-Jet II, powered by FJX-1s.*

high-tech corporate heavyweights, and an exclusive deal with Williams for the EJ22, Raburn launched Eclipse Aviation in March 2000. Williams, citing the Eclipse deal, persuaded NASA to skip the FJX-2 flights in the V-Jet II. This enabled Williams to get its final GAP payment sooner and turn immediately to the task of transforming its test-cell tour de force into a viable FAA-certified engine.

Exactly how did such a little engine achieve such extraordinary performance? Officially, nobody's saying. The Williams company, privately held and with a long history of military projects, is secretive about technical details. NASA and Eclipse people who worked on the project, bound by confidentiality agreements imposed by Williams, are likewise mum.

"I think I can tell you that the main reason for the engine's light weight is the architecture," says NASA's general aviation champion, Bruce Holmes, referring to the configuration of a jet



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engine's fan, compressors, combustor, and turbines. "But I'd go to jail if I told you what that architecture was."

Holmes can rest easy. I managed to ferret out the FJX-2's architectural secret anyway: Instead of the usual two compressors, it had three, each spinning independently at its optimum rotation speed on one of three concentric shafts and driven by its own turbine. Designers call this unusual configuration a three-shaft, or three-spool, en-

gine (see "Spools," above).

The giveaway is on the instrument panel of the original Eclipse 500. Most jets have two readouts: N1 for the low-pressure (LP) compressor/fan, and N2 for the downstream high-pressure (HP) compressor. The Eclipse had an N3 gauge, which points to the presence of a third, intermediate-pressure (IP) compressor. Ed Lays, a retired Williams engineer not bound by any secrecy agreements, confirms that the FJX-2



*The EJ22, shown here complete with plumbing, cables, and partial nacelle, would have offered a power-to-weight ratio of 9:1 and unprecedented fuel efficiency. Take a good look; it has vanished from its maker's catalog. Meanwhile, Eclipse now flies four test craft, all PW610-powered (opposite, minus one).*



WILLIAMS INTERNATIONAL

was a three-shaft design.

A three-spool engine can be very efficient. "It gives you a lot of flexibility in matching compressors and turbines," says Burkardt ("Not that I'm saying the FXJ-2 was or was not a three-spooler," he adds dutifully). However, a three-shaft engine is mechanically complex, with "bearings and seals out the ying-yang," in the words of Teledyne CAE veteran designer Gerry Merrill. Only two three-spool engines have ever been certified for commercial use: the Rolls-Royce RB.211 family of airliner engines first certified in the '70s, and the Garrett ATF3, a fearsomely complex and troublesome bizjet engine that flopped in the marketplace 10 years later.

The decision to abandon the simple, well-proven two-shaft configuration of all previous Williams fanjets set off controversy within the company. "Some of the guys who'd worked on the FJ44 didn't have much confidence in the EJ22," says Lays, who explains that one impetus for the three-shaft design came from Sam Williams' son Gregg, then a Williams VP and now company president, who'd spent two years working with Rolls-Royce on the RB.211. "Gregg was hooked on three-spool engines back then," Lays recalls.

The axial high-pressure compressor showcased at Oshkosh was also a departure for Williams, which had used centrifugal compressors in all its previous engines (see "Compressors," p. 23). Other rumored design features—compact in-line combustors, tiny integral accessories mounted directly on the main shaft—will not be revealed

until next year, when a five-year NASA embargo on the release of FJX-2 technical publications expires.

The key to the FJX-2's extraordinarily light weight was its manufacturing technology. Williams, with decades of experience building jewel-like cruise missile engines, is unrivalled in its ability to craft tiny, durable jet engine parts with great precision. Burkardt quotes one of the losing bidders for the GAP program at the Oshkosh show where Williams exhibited its tiny compressor. "The guy told me, 'Now I know why you chose them instead of us,'" Burkardt recalls. "No other company could build this engine."

**B**ut could Williams get it certified? While the FJX-2 merely had to produce thrust in a test cell, the EJ22 would have to pass a battery of FAA tests to prove that it could start reliably, run without a hiccup for thousands of hours, supply bleed air for pressurization and de-icing, run a generator, be easy to service and repair, and survive the real-world ingestion of gravel, ice, and birds. (Birds do not scale down either; an EJ22 swallowing an FAA-mandated four-pound bird is the equivalent of a Boeing 777 engine ingesting a small cow.)

While Williams wrestled with these challenges, Eclipse began building the first test airframes. By the summer of 2002, the airframe of N500EA was ready to go. Williams, although behind schedule, was reporting good progress with the engine development. So it was with keen anticipation that some 50 Eclipse

employees gathered in the 2 a.m. darkness to welcome a Falcon jet freighter as it pulled up to the Eclipse hangar. The first EJ22 was off-loaded, uncrated, and gently set down on the hangar floor. "It was pretty and new and shiny, and everybody just sat there stroking it," recalls Raburn. "It was fantastic."

The euphoria died, however, when the engine refused to start. It took an impromptu mixture adjustment, over the objections of Williams engineers, to get it going. And that was just the beginning. The starters overheated and failed. Seals leaked. Shrouds cracked. Fan blades broke. The fuel controller had problems. Serious snags bedeviled the integration of the engines to the airframe. "Within a few days we realized that the engine was massively immature," recalls Raburn.

To make matters even worse, the EJ22 had not been designed to be repairable or serviceable in the field. "We had to ship engines back to Williams 15 or 20 times in the first 90 days," says Raburn. "The air freight company ended up just basing their plane here. The pilots told us, 'We're not flying back

ECLIPSE AVIATION







home, because we know you're going to need us again in a few days.' ”

After about six weeks, Eclipse managed to get two engines running at the same time. (Still, one wouldn't start for the official rollout ceremony, so the airplane had to be towed out of its hangar to meet the aviation press.) Eclipse discovered that at high power settings, the EJ22s ran hot and could not achieve their expected thrust without exceeding inter-stage turbine temperature limits. On that anemic first takeoff, it was the combination of those temperature limits and density altitude that reduced the engine thrust to barely half the nominal 770 pounds.

Disillusioned with Williams, Eclipse brought in an outside consultant, who concluded that the engine was, at best, still two or three years away from certification. Eclipse had neither the time nor the money for such an extended effort. “The core problem was that the EJ22 was radically more complex than anything Williams had ever done before,” says Raburn. “It was so tiny and so complex that we came to believe it could never be robust enough to op-

erate the way our customers were going to operate it. It's got to be a bullet-proof engine that just runs and runs and runs. The EJ22 was never going to do that. It was like a Ferrari V-12 in a New York City bus.”

After being dropped by Eclipse, the EJ22 quickly disappeared from public view. Williams removed all mention of it from the company Web site, and halted efforts to have it certified. “There's no airplane out there for it,” explains Sam Williams in an odd reversal of the bold “If you build it they will come” philosophy that drove the company to dominate the cruise missile and light business jet marketplace.

Still, the company continues to work on the EJ22's technology. “We've had that configuration up to 1,000 pounds thrust,” says Williams, presumably referring to a somewhat similar engine the company is pursuing for the Department of Defense's VAATE (Versatile Affordable Advanced Turbine Engine), sort of a military version of the GAP program. With DOD money, efforts to certify the EJ22 could still be revived if the right airplane came along.

**W**hy did the EJ22 fail? Perhaps Williams overreached by abandoning the core design philosophies of simplicity and incremental change that had served the company so well over the years. Tellingly, Williams returned to those core values last year with its smallest FAA-certified engine in company history: the FJ33. It's nothing fancy, just a simple, robust two-shaft engine of 1,000 to 1,500 pounds of thrust that is essentially a scaled-down version of the FJ44. Already, half a dozen new VLJs are being designed around it.


Despite its ultimate failure as a commercial engine, the EJ22 was a conceptual breakthrough. It inspired the VLJ category, which NASA predicts will grow to a fleet of 13,500 by 2025, in the same way that earlier Williams engines inspired the cruise missile and light bizjet categories. Without the EJ22, there would be no Eclipse 500, no realistic hope of jet travel within reach of thousands of new customers. Even Raburn, despite the enormous angst the EJ22 caused him, concedes, “It was certainly a noble experiment.” —





# "A FULL RETALIATORY RESPONSE"

When the Cuban missile crisis flared in 1962, Strategic Air Command crews were one step away from nuclear war. | by Thomas D. Jones  
Photo-illustrations by David Povilaitis



tanding on a stepladder in the gloom of the B-52's cavernous bomb bay, I squeezed between the lower pair of torpedo-shaped nukes—B28FI thermonuclear weapons—and aimed an inspection mirror and flashlight at the circular viewports on each: “safe” indicators visible, yield settings correct. Satisfied that our bomb load was dormant, the navigator and I connected the mechanical bomb door actuators and backed carefully out of the bay. With the pilot and gunner, we shouldered the heavy doors, sticky with hydraulic fluid, and slammed the latches home with a solid *thunk*.

*Under the cover of B-52s on alert—their crews trained and ready (left)—the U.S. ambassador to the U.N. confronted the Soviets.*







U.S. AIR FORCE

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FIVE CENTS

## U.S. IMPOSES ARMS BLOCKADE ON CUBA ON FINDING OFFENSIVE-MISSILE SITES; KENNEDY READY FOR SOVIET SHOWDOWN

Open New Front; SHIPS MUST STOP







In the crew compartment, the radar navigator—who on a B-52 serves as the bombardier—and the electronic warfare officer wrapped up their inventory of our code documents and strike folders. Then the six of us hopped into an Air Force-blue, six-passenger pickup and headed to “the vault.” For the next three hours, we sat within a guarded, windowless, single-story, cinder-block bunker to study the inconceivable: the part we’d play in global thermonuclear war.

Our sortie was just one strike mission in the Single Integrated Operational Plan, a Strategic Air Command script for thousands of aircraft and missile attacks against the Russian homeland in response to a Soviet assault. Laid out in meticulous detail in our strike folder were flight routes, refueling tracks, bomb run airspeeds, our positive-control turnaround point—where we would turn back unless we received a radio order to strike—and finally, deep in the Soviet Union, four targets, one for each of our 1.1-megaton weapons.

In the vault, my crewmates, who ordinarily wouldn’t go more than a few minutes without a joke or good-natured ribbing, were deadly serious. As we concentrated on the maps, the nav team explained how they would take us in and out of the target areas; we discussed countermeasures, fuel reserves, how we would link up if forced to bail out. I was on alert from 1979 until 1983, and each time we studied

the SIOP, I knew our six-man combat crew was ready—skilled, trained, willing—to execute a mission from which we would likely not return.

I have wondered since then what went through the minds of other Strategic Air Command crews who, 20 years before my crew met in the vault, came much closer to flying those missions than we did. The bomber crews on alert during the 1962 Cuban missile crisis were studying the SIOP at the only time in the history of the cold war when U.S. forces reached Defense Condition 2. At DEFCON 1, those SAC crews would have been dropping bombs.

“I thought it was unlikely that we would complete the entire mission,” says Augustine R. “Gus” Letto, who, when the missile crisis broke, was a captain and EB-47E copilot with the 353rd Bomb Squadron at Lockbourne Air Force Base in Ohio. “My personal hope was that we could complete enough of the mission to support the low-flying strike aircraft.” The EB-47s were high-altitude jammers, exposed to fighters and surface-to-air missiles. “I decided that the world as we knew it would be at an end,” Letto continues, “and that my family, if they were lucky, would not survive the initial nuclear exchange.”

Letto, 30 at the time, was pulling the week-long ground alert tour required of every SAC crew member nearly twice a month. Crews on ground alert were expected to take off, ready for combat, within 15 minutes of the order to launch. For the entire week they were on alert, they lived in a partially buried, concrete-block alert shack. “We had spent the whole afternoon [of October 22, 1962] in the ‘mole hole’ when they announced a meeting for aircraft com-

manders only,” he says. Outside, Letto saw crew chiefs and technicians at work on the wing’s EB-47s: topping fuel tanks, loading 20-mm ammo for the twin tail cannon, installing JATO (jet-assisted takeoff) bottles—in short, preparing the bombers for combat.

### To the Brink

Six days earlier, on October 16, President John F. Kennedy’s Executive Committee had begun to act on intelligence gathered by U.S. Air Force U-2 reconnaissance aircraft: The Soviet Union was preparing to deploy medium-range R-12 missiles in Cuba. The missiles had 2.3-megaton warheads and a 1,100-mile range. They could reach Philadelphia, St. Louis, Oklahoma City, San Antonio, and the Panama Canal. (Photo-interpreters discovered that Soviet technicians were also preparing sites for 16 intermediate-range R-14 ballistic missiles, with a range of 2,300 miles.)

The U.S. Joint Chiefs began planning air strikes to destroy the missile emplacements and to support the invasion of Cuba that would follow. SAC’s commander, General Thomas S. Power, was a hard-bitten veteran of the B-29 bomber campaign against Japan in World War II; his wartime superior and predecessor at SAC, Curtis E. LeMay, was now Air Force Chief of Staff. Both men saw two roles for the Strategic Air Command: to deter any Soviet offensive action and to meet any Soviet attack from Cuba with a massive retaliatory strike against Russia.

The feverish activity that Gus Letto witnessed from the alert shack on October 22 was a response to a message from the Joint Chiefs sent that afternoon: U.S. forces worldwide were to

chat  
BLOCKADE BEGINS  
AT 10 A.M. TODAY





*U-2s and other reconnaissance aircraft kept watch on Cuba, finding, in November 1962, surface-to-air-missile sites (left). Opposite: To boost launch, crews loaded B-47s with jet-assisted takeoff bottles.*

go to DEFCON 3 at seven that evening. At SAC bases around the world, both air and ground crews raced to get every flyable bomber and tanker “cocked.”

The Strategic Air Command of the 1960s was a highly trained and disciplined organization. Aviation historian Alwyn T. Lloyd says that after LeMay took over as SAC commander in October 1948, he turned the command around. “He was appalled at the lack of readiness,” says Lloyd, so he instituted rigorous training programs and competitions to keep the crewmen sharp. “He created the Spot Promotion program in which an entire crew was promoted one grade for winning the Bomb Comp,” says Lloyd. “If any member of a crew committed a major operational infraction, the entire crew was busted back one grade.”

Since May 1960, the command had been keeping more than 400 B-47, B-52, and B-58 strategic bombers—about a third of the fleet—on 15-minute ground alert. That posture, along with 10-hour-plus training missions and recurring ground instruction, pushed the average crew’s workload to a crushing 60 hours or more a week. At Altus Air Force Base, in the desolate tablelands of western Oklahoma, B-52E tail gunner Clyde Ketcham, an airman second class, was one of the young men spending half of every month on alert. For Ketcham, then 20, the week began as the others had, but “I got up one morning and they had all these guys with

carbines around the alert shack,” he says. “They had cooks, civil engineers—they had everybody out there. They just locked down the base.”

At 7 p.m. that evening, President Kennedy gave a 17-minute speech announcing “a quarantine on all offensive military equipment” headed to Cuba. The blockade was to begin at 10 a.m. on October 24. Kennedy warned Soviet Premier Nikita Krushchev that the United States would “regard any nuclear missile launched from Cuba against any nation in the Western Hemisphere as an attack by the Soviet Union on the United States, requiring a full retaliatory response against the Soviet Union.” At Altus, Ketcham and his 26th Bomb Squadron crewmates were briefed by wing staff: “If the buzzer blows, it’ll be the real McCoy.”

### **Calling All Bomber Crews**

Deep in the Canadian forest, 200 miles north of Michigan’s Wurtsmith Air Force Base, Captain Dan Zahhos, a B-52H radar navigator, was wrapping up a successful hunting trip. He and a friend pulled into a small town with their trophies and were relaxing in the bar, watching TV, when, Zahhos remembers, “here comes the president. It just blew us over.” He drove straight back to his parents’ home in Minnesota, where he “laid out a fairly detailed plan for my whole family on how to evacuate. I would get word to them,” says Zahhos, then 28, “to get the hell out of

Minneapolis if it got that bad.”

The recall from the Wurtsmith command post came at 4 a.m. Within half an hour, Zahhos hit the road to the base, 400 miles to the northeast. Zahhos’ colleague, Captain Bill Brown, was on leave in Iowa when he heard the president’s speech. Recalled that night, Brown jumped in his 1960 Volvo. “I drove 640 miles in 10 hours,” Brown says, “and didn’t see a single cop.”

As SAC airmen streamed back to bases across the country, the command was readying Atlas and Titan intercontinental ballistic missiles for firing. Bomber crews based at southern airfields were redeployed north, both to get out of Cuban missile range and to free up ramp space for tactical aircraft supporting a Cuban airstrike option. First Lieutenant Harold W. “Bud” Andress, a 524th Bomb Squadron navigator at Wurtsmith, remembers what the base looked like in the week following the president’s address. “The 19th Bomb Wing from Homestead [Florida] joined us. We had airplanes parked all over, on every piece of concrete we had. Their alert crews bunked in the bachelor officers’ quarters, the fire house, wherever....”

First Lieutenant E.G. “Buck” Shuler, today a retired general, was on alert with his B-52F crew at Carswell Air Force Base, near Ft. Worth, Texas. “We cocked every airplane we had,” he says. “Everybody was target-studied. There were no training flights, no ground training, no nothing. We were ready to go to war.”

Wary of a nuclear Pearl Harbor, SAC had, since 1961, been keeping about a dozen B-52s in the air at all times—armed and ready to strike. At noon on the 22nd, the command began launch-



ing additional Stratofortresses, and by the time of President Kennedy's TV address, 66 B-52s were in the air, each carrying up to four hydrogen bombs, some with a pair of Hound Dog nuclear-tipped cruise missiles. The 66 bombers made up the first wave of a continuous airborne alert posture that was sustained for four weeks.

Flying in pairs, the Stratofortresses cruised to holding zones in the Mediterranean, north of Greenland, and along the Alaskan frontier. Each would remain on station for 24 hours until relieved by a fresh aircraft. The long-duration missions were known by the call sign "Chrome Dome."

"The mission wasn't that demanding, believe it or not," says Craig A. Mizner, a captain and experienced B-52F copilot in October 1962. "We took turns at the controls." On one mission, Mizner's crew headed across the Atlantic, past Gibraltar, and refueled over the Mediterranean. "We got as far east as Crete. The EW [electronic warfare officer] reported being scanned by radars out of Libya. I remember seeing some aircraft north of there that we later heard were MiG-17s."

First Lieutenant Gary M. Jacoby, an EW on an Oklahoma-based B-52E, took off on a northern route, his flight lasting more than 23 hours. "We went out over the east coast, up to within two or three hundred miles of the North Pole, then over to Alaska, down, and came in over the California coast," he recalls. If ordered to attack, "we knew

we'd probably encounter hundreds of SAMs [surface-to-air missiles]. We knew we were going to have a job ahead of us if we ever did go to war, but we felt very confident that we could get the job done."

Jacoby's crew refueled at least twice during their sortie; aerial fill-ups from SAC's KC-135 and KC-97 tanker force were critical to the airborne alert mission. By 1978, when I was flying the B-52D, pilots got an assist from the autopilot's aerial refueling mode, which gave the yoke a "power steering" feel and automatically trimmed the airplane as fuel coursed into my bomber's wing and fuselage tanks. Still, the intense concentration and hard work left me drenched in sweat.

The B-52s of 1962 lacked that modification, and pilots had to muscle their way through an hour behind the tanker, jockeying the aircraft as they took on every last drop of JP-4 they could carry. (The tankers had wartime orders to keep "passing gas" until their own engines were about to flame out.)

"You were trying to get 128,000 pounds of gas on the airplane, and trying to do it in one gulp," Buck Shuler remembers. "We went to full tanks over the Med. It was a very physical thing. You were on that boom 28 or 30 minutes. I can recall practically slumping over the column after backing off."

Orbiting at their positive-control turnaround points, the crews monitored radio traffic, listening for the Emergency War Order from SAC head-

quarters in Omaha to come crackling over the bombers' long-range, high-frequency sets. At least two crew members were to copy the message, then compare its numbers and letters to on-board decoding documents. The voice messages would either recall them or commit them to strike their targets.

"As a 21-year-old I was very confident in the B-52H," recalls Lee T. McCoy Jr. of Endwell, New York, who was an Airman Second Class tail gunner in the early 1960s. "My aircraft commander had survived World War II—and I thought he was the best—our EW was good, the navigator was excellent, the radar navigator [bombardier] never missed, and I had a Gatling gun in the tail that could take out air-to-air missiles. I had extreme confidence in the aircraft and the crew. Looking back, I was probably very naive. I thought I'd be coming home."

### Just One Reason

Bombs on target: For every member of a SAC crew, that's what mattered. The plan was to penetrate Soviet airspace at low level and high subsonic speed, to stay below Russian radar, and to skirt known defenses. Approaching the target, B-47 crews would zoom upward, toss their H-bombs toward the aim point, and complete a 180-degree Immelmann maneuver to escape the blast (see "Exit Strategy," Apr./May 2003). In the less agile B-52, crews delivered their weapons from 400 feet or lower, running in at 400 to 440 mph. With the bombardier fixing his radar scope cross-hairs on a nearby building or terrain feature—an "offset"—that gave a bright return, the B-52's analog bombing computer would crank in the offset-to-target distance, speed, heading, and weapon ballistics, then send steering signals to the pilot data indicators on the flight deck instrument panel. Upstairs, the aircraft commander flew the airplane so as to keep the PDI needle centered at the top of its instrument case. Twin second hands on either side of the needle ticked off the time to bomb release. At 10 seconds to go, high-pressure hydraulics snapped the bomb bay doors open into the slipstream.

It happens very fast: You can hear and feel the subdued roar of extra drag

## THE BOMBERS

The U.S. bomber fleet, nearly 10 times the size of the Soviet Union's, consisted of 1,300 Boeing B-47 and B-52 aircraft (a few B-58 Hustlers were also operational). The B-47 Stratojet, first flown in 1947, was a revolutionary swept-wing medium bomber; six turbojets gave it a maximum speed of 610 mph. The three-man crew could deliver 10,000 pounds of bombs to targets 3,500 miles away at near-supersonic speeds; it was faster than most jet interceptors of the day.

Boeing followed the B-47 with history's longest-flying strategic bomber, the B-52 Stratofortress. In the decade before intercontinental missiles became dominant, the B-52 was SAC's roundhouse punch, capable of flying from the continental United States and striking the Soviet Union. At twice the gross takeoff weight of the B-47, it had a top speed of more than 620 mph and could reach a target 3,300 miles away. The BUFF (an acronym politely translated to "big ugly fat fellow") entered service in 1955, and by October 1962 Boeing was delivering the final Stratofortress version, the B-52H. Its turbofan engines gave it a combat radius of 4,300 miles and a top speed of 650 mph.





*Curtis LeMay (top) and Thomas S. Power believed their crack bomber force and crews would make the U.S.S.R. back down. At SAC HQ (left), staff tracked airborne B-52s.*

in the slipstream, confirming the gleaming yellow warning light on the pilot's panel: "Bomb Doors Open." The radar-nav's call of "Bomb Away!" is followed quickly by the thump of the doors closing, and the Stratofortress once again slips smoothly through the dangerous air, racing over—and away from—the target. The bomb's delay fuse would allow the B-52, running flat out at 400 mph, to escape the fireball, blast, and intense heat. At least that's what the tactics manual promised.

"I felt it would be a one-way trip," says Clyde Ketcham. "Even if not shot down, after flying through all the ra-

dioactivity, I don't think we would have lived very long, and on most missions, we had very little fuel left and really no friendly places to go after the last target. I think most crew members held down at the very bottom of their soul [the thought] that God wouldn't let this happen. That's how I kept my sanity."

Buck Shuler remembers four main target "sets" in the SIOP, designed to erode the Soviets' ability to cause further damage to the United States. "We would strike the leadership, their strategic retaliatory capability, general military [targets], and then their industry and ability to reconstitute. I can remember vividly the aiming point of the first weapon was the southwest corner of the Kremlin."

After the president's television address, SAC dispersed many of its B-47 squadrons to civilian airfields. The

move complicated Soviet targeting and made room at crowded SAC bases for bombers displaced northward by U.S. invasion preparations.

Gus Letto came off alert in Ohio and joined other crews on a C-47 transport bound for Philadelphia International Airport. There they found three EB-47 jamming aircraft, which would penetrate the Soviet Union ahead of the bomber force, cocked and ready on the Air National Guard ramp. "SAC had taken over the [Guard] command post and quartered us in an airport motel," Letto recalls. "They handed us credit cards and arranged for the B-47 crews to run a tab at the main terminal's dining room. We ate in flightsuits, loaded .38s in our shoulder holsters."

A portable radio monitored emergency message traffic. Letto says crews listened for a coded signal to be broad-

SOURCES: USAF, ALWYN T. LLOYD



cast over the airport PA system: “Dr. Mordecai, please call your office” would signify “Start engines.”

Letto is still amazed at the war footing SAC went to in 1962. His friend Jim Griggs, a B-47 navigator for the 310th Bomb Wing at Schilling Air Force Base in Kansas, spent almost the whole crisis period at Port Columbus Airport in Ohio with nuclear-armed aircraft ready to launch on the retaliatory mission. “I can’t imagine Americans’ reaction today,” says Letto, “if we scattered nuclear-armed bombers to dozens of airports around the country.”

### One Step Closer

On the morning of the 24th, a pair of Soviet freighters approached the 56 U.S. warships that had set up a quarantine line 500 miles from Cuba. The Navy reported that a submerged Soviet sub was escorting the two cargo ships headed toward the line. A confrontation appeared inevitable, and, at the direction of the Joint Chiefs, SAC went to DEFCON 2.

Generals LeMay and Power believed that SAC’s deterrent value lay largely in convincing Soviet leaders that the United States had an unstoppable nuclear striking force and would not hesitate, if threatened, to employ it. When the alert level reached DEFCON 2, Power decided to make sure that Krushchev understood its significance. He broadcast, on his own authority, an “in the clear” radio message to SAC commanders worldwide—a message certain to be heard by the Soviets: “We are in an advanced state of readiness...and I feel that we are well pre-

pared. I expect each of you to maintain strict security and use calm judgment during this tense period.... Review your plans for further action to insure that there will be no mistakes or confusion....”

It was a controversial action; some historians of the crisis believe the broadcast was a dangerous provocation instead of an attempt to demonstrate to the Soviets the terrible consequences of a wrong move. But the rank and file were also making their presence known. As Alwyn Lloyd writes in his SAC history *A Cold War Legacy*, to impress the Soviets, Chrome Dome bombers transmitted twice the normal number of position reports. To Dan Zahhos, an experienced bombardier, “the radio traffic sounded like Grand Central Station—there were so many aircraft up there! Once in a while we’d get interference from a poorly disguised Russian [voice] trying to disrupt our operations.” Zahhos had minored in Russian in college; “I got on the radio and started speaking Russian to him.” The imposter laughed, answering, “Over here, we’re ready for whatever you’re trying to do.”

On October 24, the United States had 2,952 nuclear weapons on alert, with a total explosive yield of well above 5,000 megatons. A single megaton is roughly 77 times the explosive power of the bomb dropped on Hiroshima in 1945.

Lee McCoy recently reflected on what it was like to be carrying part of that load: “This realization really came home to me on an airborne alert mission out over the Mediterranean. I was in a huge airplane carrying several nuclear weapons, and within an hour of killing maybe several millions of people very much like my own mom and dad.”

In Texas, Buck Shuler had told his wife and visiting mother-in-law that if war came, the Carswell base would be targeted. “I kind of drilled her on it, and we kept a kit together,” he says. “When we went to DEFCON 2, Annette had the car packed with blankets, extra baby formula ....”

Of course the bomber crews had also drilled for that eventuality. A Soviet missile attack would give them only minutes to save as many bombers as possible for the counterpunch. The crews practiced MITO, or minimum interval takeoff, designed to get the maximum number of aircraft launched in the minimum amount of time (see “Gone in 144 Seconds” at [www.airspacemag.com](http://www.airspacemag.com)).

### One Step Back

The Soviet freighters bound for Cuba altered course at the last minute, and Secretary of State Dean Rusk whispered his now-famous observation to Kennedy advisor McGeorge Bundy: “We’re eyeball to eyeball, and I think the other fellow just blinked.”





But U.S. forces couldn't be sure: In Cuba, Soviet technicians continued to rush the completion of launch sites for R-12 medium-range ballistic missiles. On October 25, the U.N. Security Council convened an emergency session at its headquarters in New York. There U.S. Ambassador to the United Nations Adlai Stevenson displayed the U-2 reconnaissance photographs showing the placement of Soviet offensive missiles in Cuba. Then, on October 27, SAC U-2 pilot Major Rudolph Anderson Jr. died when his aircraft was shot down over Cuba by a Soviet SA-2 "Guideline" missile. The White House mulled an air strike to destroy the responsible SAM battery, and the Kremlin braced for Kennedy's response.

Mike Jones, today a retired master sergeant who was a B-52E assistant crew chief at New Mexico's Walker Air Force Base in 1962, worked an endless string of 12-hour shifts during those late October days. "In that hair-trigger atmosphere, I thought we were very likely to have a war," he says. "We slept at the airplanes, ate box lunches brought out to the flightline. We were working at a fever pitch."

Other SAC personnel found themselves suddenly reassigned. James D.

Rusher was an 18-year-old "two-striper" (airman second class), fresh out of basic and attending the B-47 crew chief school at Amarillo Air Force Base in the Texas panhandle. The Saturday that Anderson's U-2 went down, Rusher and hundreds of other SAC trainees assembled in front of a flatbed truck rigged as a speaker's platform. "We watched an Army staff car roll out of a cargo plane and drive across the ramp," he says. The group snapped to attention; the base commander announced a ban on "all letter-writing, all phone calls, all passes, and all leaves." Next a brigadier from Ft. Benning (home of the Army's Rangers) addressed the airmen. "He told us that as of right then, we were on two hours' notice for deployment to Benning," says Rusher. "There we'd get two days of rifle and infantry training, then join the invasion force headed for Cuba."

Gus Letto imagines that in the last days of October 1962, Krushchev was like a man looking down the barrel of a loaded gun. "In the final determination he knew that if he made a wrong move, three hours later he'd have B-47s and B-52s appearing on his radar."

On Sunday morning, October 28, the CIA reported to the White House that all 24 R-12 missile sites were now op-

erational. But later that morning, in return for Kennedy's promise to lift the quarantine and the invasion threat, Krushchev drew back from the brink. In a Radio Moscow broadcast, he announced that the "so-called offensive weapons" in Cuba would be dismantled, crated, and returned to the Soviet Union. U.S. forces remained on high alert, but in Washington, there was a sense of relief and exultation.

SAC remained at DEFCON 2 as Kennedy pressed for the removal of Soviet Ilyushin Il-28 "Beagle" bombers from Cuba. When Krushchev finally agreed to withdraw them, the president reciprocated by ending the naval quarantine. Shortly before noon on November 20, after 27 days at DEFCON 2, SAC stepped back from the nuclear threshold.

During the Cuban crisis, over 90 percent of SAC's bomber force had been poised to launch within 15 minutes of the klaxon sounding. According to Alywn Lloyd's *A Cold War Legacy*, the command flew 2,088 sorties during the affair. Eight airmen died. The same day Major Anderson's U-2 was downed, an RB-47 crashed on takeoff from Bermuda; all four crew members were killed. Another Stratojet crashed at MacDill Air Force Base near Tampa on November 11, killing three more.

During those weeks of enormous strain, SAC crewmen found comfort in the commonplace: a rare family meal, the welcome routine of household chores. At the height of the crisis, Letto rotated off alert duty to go home and get some rest. He remembers going out to his front yard to mow the lawn—"just to do something useful," he says. "One of our neighbors saw me, came straight across the street, and gave me a big hug. I asked her, 'What was that for?'"

Letto still laughs at her answer. "If the Air Force can afford to let you guys come home and cut the grass," she said, "maybe we're going to live through this." —

*Even today, B-52s carry a range of weapons. In the '60s, some carried the Mark 41 H-bomb (opposite), which packed a 25-megaton punch. No wonder Soviet ships halted delivery of their cargo that October.*



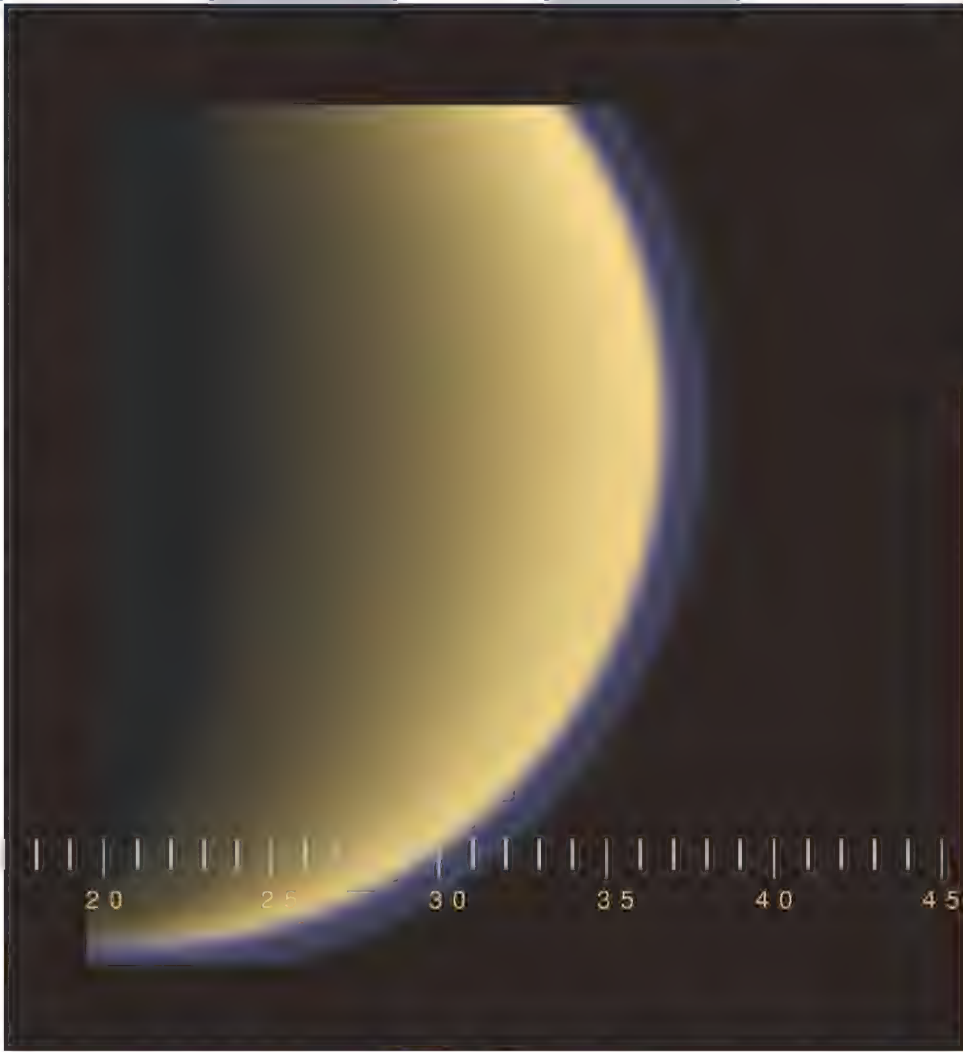


# 219

## MINUTES

## ON TITAN

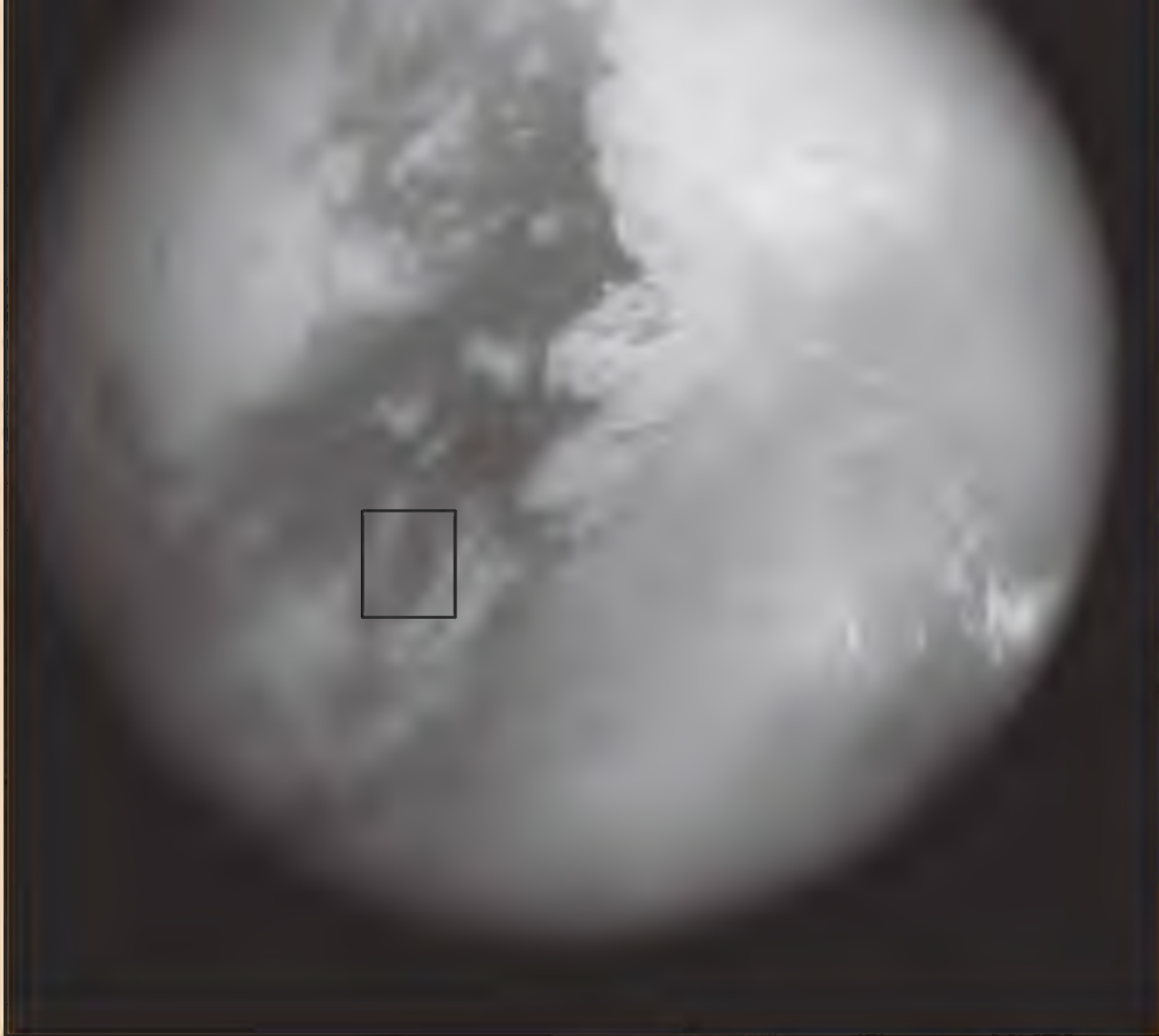
On an uncharted world, a little spacecraft saw a lot in a very short time. by Tony Reichhardt





*Titan's orange haze (opposite), apparent even to cameras on the Saturn-orbiting Cassini spacecraft, results from sunlight breaking down methane in the atmosphere. For the view at left, taken by Huygens on Titan's surface, scientists added color to approximate what our eyes would see. The rounded pebbles of rock-hard ice are a few inches wide. At first a penetrator on the lander reported a hard crust over the soil, but in reality it had only struck a pebble on its way through the surface.*

ESA/NASA/JPL/UNIVERSITY OF ARIZONA (4)

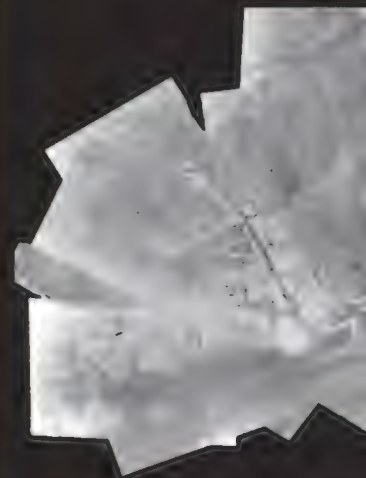


*Huygens scientists knew ahead of time roughly where their probe would come down (above, square), but not what it would see as it descended. Some of the scenery near the touchdown point (left) looked surprisingly like a coastline on Earth, with dark liquid-methane river channels (the widest is about 50 yards) emptying into a dark dry lake bed.*

**S**avor the pictures on the next few pages. Spend some time with them. They're as rare and precious as anything ever returned from space, and we're not likely to get more for a very long time. The images were taken last January by the European Space Agency's Huygens probe as it parachuted to a soft landing on Saturn's moon Titan, three-quarters of a billion miles away. As the 700-pound craft descended for two and a half hours through Titan's orange smog, swaying gently beneath its parachute, it turned slowly around its axis so onboard cameras could take in the full 360-degree panorama below. Before landing, it switched on a feeble 20-watt lamp to illuminate Titan's dark surface. Scientists hadn't expected to see much until Huygens got down to about 200 yards—sunshine on Titan being 1/1,000 what it is on Earth. But when the craft had reached about 20 miles, the first features of an alien landscape came into view.

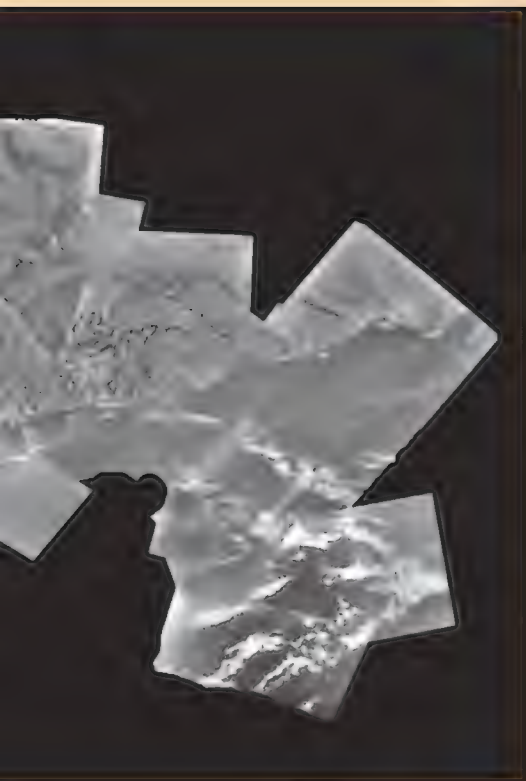


*During their descent, Huygen's cameras pointed erratically, so every part of the full panorama of Titan did not get equal coverage. As luck would have it, the landing site itself (below) was not imaged at high resolution. As worse luck had it, operators transmitting software to the Cassini orbiter dropped the command to listen to one of Huygens' channels, so half the pictures sent by the landing craft were lost.*



ESA/NASA/JPL/UNIVERSITY OF ARIZONA (3)





*Above left: This composite image of a Titanian shoreline is what you might see out the window of an airplane flying about 25,000 feet above Titan. The smallest visible detail is about 65 feet wide. Above: Wispy white features off the coast, scientists believe, may be fog or clouds.*

Jonathan Lunine, a University of Arizona planetary scientist who had spent much of his career anticipating that moment, still marvels at the images, especially considering that they were taken “from a swinging platform, in the haze, in the equivalent of what would be deep twilight on Earth, of something that has the brightness of an asphalt parking lot.”

Another member of the Huygens camera team, U.S. Geological Survey scientist Laurence Soderblom, laughs at the idea that anyone could be disappointed with the photos. “People want to know why they don’t look like they came out of *Life* magazine!”

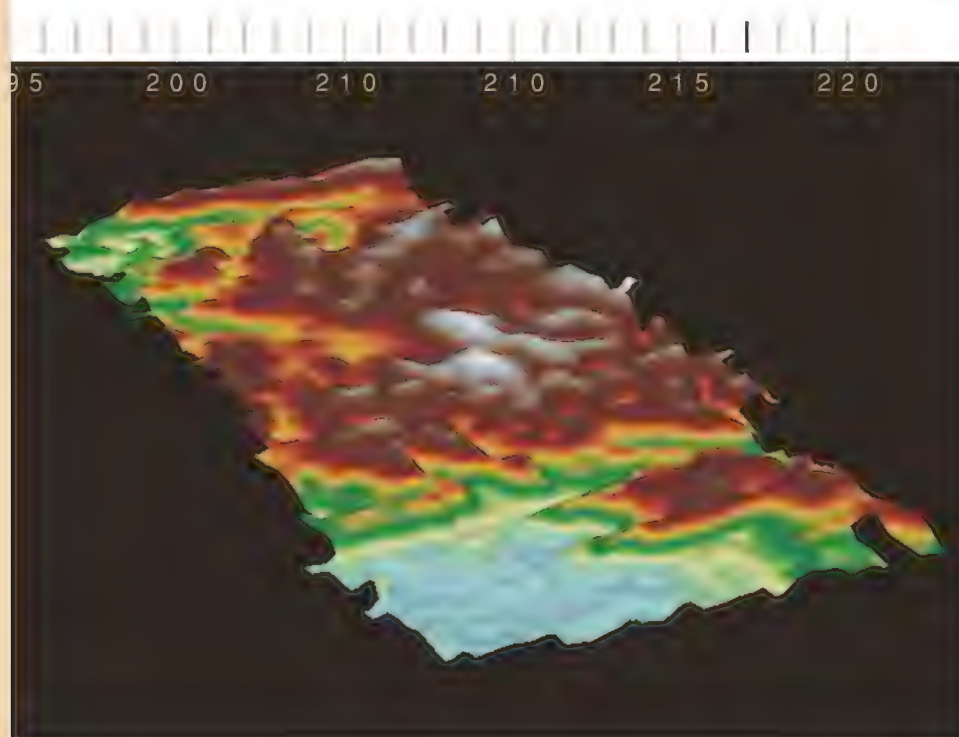
Huygens transmitted pictures and data from the surface for one hour, 12 minutes, and nine seconds, far longer than expected. A stick-like penetrator poked into the ground to test its firmness. Another instrument heated up the soil, a process that immediately triggered a release of gas, suggesting the presence of liquid methane not far below the surface. The scientists liken the landing site to a dry stream bed.

It may be dry today, but the descent pictures clearly revealed branching river channels, evidence of rain and erosion in some distant—or perhaps even recent—past. Huygens showed the landing site to be “a very strange but weirdly Earth-like area,” says Lunine.

Strange is right. It’s hard to get your head around Titan. The temperature is  $-290$  degrees Fahrenheit, about the same as the temperature inside the space shuttle’s liquid oxygen tank. In this frigid world, the bedrock is hard water ice. Methane is a thin, gasoline-like liquid that occasionally rains on the ice mountains and washes down smog particles, which then settle over the landscape like a black film. Instead of molten rock, volcanoes ooze what scientists call a cryolava—a mixture of water and ammonia. At Titan’s temperatures, the stuff would be as thick as warm taffy.

Lunine and other Huygens team members are still poring over the 219 minutes’ worth of Titan images, and expect to learn more from the Cassini orbiter, which dropped off the probe last December and is still circling Saturn. In October Cassini will fly over the landing site and make the first radar images; these will help scientists interpret what they saw in January.

Meanwhile, Lunine, Soderblom, and the rest have a total of 606 pictures taken by the one and only spacecraft ever to land in the outer solar system. No follow-up visit to Titan is currently planned. Lunine says that as he watched the pictures come up on a screen in the Huygens mission control room in Germany on January 14, “the first thought that came to my mind was incredible elation. And the second was depression, because I was seeing all the [close-ups of Titan] I’m going to see until I’m an old man. If I’m lucky.” —



*U.S. Geological Survey photo specialists combined two Huygens images of Titanian channels (opposite) to produce this artificial stereo view. The elevation range is about 200 yards from the highest peaks to the river bed. The canyon slopes are fairly steep—about 30 degrees.*

ESA/NASA/JPL/UNIVERSITY OF ARIZONA/US GEOLOGICAL SURVEY





# *The* **Raptor** *Arrives*

DEBRIEFING THE PILOTS WHO GOT FIRST  
CRACK AT THE F/A-22. *by Carl Hoffman*





AIR FORCE CAPTAIN MICHAEL "WACO" CABRAL CAN BARELY REMEMBER HIS FIRST FLIGHT IN A NEW F/A-22 RAPTOR. HE RECALLS FEELING IMMENSE POWER AT TAKE-OFF AND THEN—A BLANK. "IT WAS JUST LIKE 'HOLY COW I'M IN A RAPTOR, HOLY COW I'M IN A RAPTOR,' AND I'M TRYING NOT TO SCREW UP."

Cabral has better recall of his fifth, sixth, and seventh flights, during which he flew his Raptor against another in a Basic Fighter Maneuvers exercise. (The second aircraft simulated a Russian Sukhoi Su-27.) "The briefer said, 'Look, BFM in the Raptor is boring.' And it was true. The plane is so powerful and responsive, it can turn so tight and sustain such high Gs and angles of attack, that I can fly to the center of his turn circle and keep my nose and weapon on him all day. Whatever he tries to do, I can just point my airplane.

"When I was flying defensive BFM, he simply couldn't enter into my turn circle. Even if he flies his weapon to the best of its capabilities and I make errors, he cannot win. It's almost too easy."

Cabral made his training flights out of Tyndall Air Force Base in Panama City, Florida. Tyndall, Edwards in Califor-

*All hail the Raptor: The first new Air Force fighter in 30 years debuted at Nellis Air Force Base to rave reviews.*





*Captain Michael Cabral climbs into an F/A-22 at Tyndall Air Force Base. Recalling his first impressions of the Raptor cockpit, he says: "It's got that new car smell." Bottom: Crew chief Jerade Sullivan prepares to launch a Raptor at Tyndall.*

JAMES R. BELLESBACH/K-MAR INDUSTRIES/TYNDALL AFB



LISA NORMAN/K-MAR INDUSTRIES/TYNDALL AFB

nia, and Nellis in Nevada are the first Air Force bases where pilots are learning how to fly the F/A-22, the Air Force's first new fighter in three decades. Like Cabral, these pilots, veterans of the F-15C, F-15E, and F-16, rave about the Raptor's performance. "It's much better than we expected," says Major Robert Garland, F/A-22 division commander at Nellis. It's revolutionary." The Raptor is the Air Force's latest air superiority fighter, but it's also intended to serve as a ground attack aircraft, one that the pilots say will "kick the doors down" and "sanitize the battle space," paving the way for waves of

F-117s and B-2s hunting surface-to-air-missile sites.

Judging by the way these new Raptor drivers talk, the training is perfect, the sims are flawless, the jet is invincible. Though they haven't flown the Raptor in combat, you won't hear them express any skepticism on that front. The reason is simple, says military analyst John Pike, director of *GlobalSecurity.org* and usually a skeptic himself when it comes to expensive new weapon systems: "The one lesson [the Air Force has] learned in the 20th century is that the people with the best airplanes win. And this is the best airplane."

Like most military bases, Tyndall looks slightly worn out. The elevators in the air traffic control tower are clunky; the carpet in the canteen is threadbare. But it's a different story in the new headquarters of the 43rd Fighter Squadron, the unit being trained to fly the Raptor. Four flat-screen televisions mounted on the wall show Fox News, satellite weather data, and flight schedules in a lobby graced with new leather sofas. The pilots' lockers are dark burnished wood. The Raptor pilots themselves are so relentlessly positive about the aircraft that you can imagine them coming from the perfect suburb of Stepford.

The first eight Air Force pilots to learn to fly the aircraft had trained at Nellis; now, they are here teaching eight Tyndall instructors in the first 18 production jets, flown in fresh from the Lockheed Martin factory in Marietta, Georgia.

The Nellis eight are "patch wearers"—graduates of Nellis' Air Force Fighter Weapons School—and instructors with a minimum 2,000 hours each in their primary fighters. At Nellis' Force Development Evaluations, where pilots brainstorm about what an aircraft is capable of, then test their speculations, these pilots developed a tactical playbook for the F/A-22.

As for the Tyndall pilots, squadron commander Michael "Bam Bam" Stapleton, 38, and operations officer David "Kooler" Krum, 37, look like frat boys, but they're both lieutenant colonels, and each has over 2,500 hours in F-15s. The others in the 43rd, like Cabral, are also young but are senior captains or majors, Formal Training Unit flight instructors with at least 1,000 hours in their primary weapons. "The cost of [the F/A-22] program is so high that every mistake will be on the front pages of the



paper,” says Stapleton. “We don’t want to steal the top guns from every squadron, but we need to put the most talented folks we can on the plane as early as we can.”

Cabral, a compact man with eager brown eyes, takes me out on the flightline. Rows of F-15s and F-16s sit uncovered against the Florida rain and sun, but the Raptors get parked in new shelters that resemble suburban carports.

Compared with their neighbors, which bristle with weapons, the Raptors look neutered; their weapons bays are internal, so the airplanes generate a much smaller radar signature. The Raptors’ stealthy shape sends most

of a radar return away from the signal’s source. The cleaner airframe also produces relatively little drag.

The Tyndall pilots’ training syllabus lasts 60 days. Cabral tells me that the first 21 days were all academic. He had to sit through 57 hours of classes (including five tests), plus 16 hours in the simulator. There are no two-seat F/A-22s, so when Cabral took off for the first time, it really was his first Raptor flight. The day before, he’d sat in the aircraft for the first time, then started it up. “It’s got that new car smell,” he recalls. “It’s louder than an [F-15] Eagle, it rumbles more, and the nose slopes down so it feels almost like you’re falling out of the plane.”

He had three basic “transition” rides—transitioning from the simulator—and a check ride, then his training continued through a series of carefully scripted steps that would simulate increasingly complex threat scenarios.

All combat jet training begins with BFM: one jet against another within visual range. Pretty standard stuff, except that in the case of the Raptor, power, big control surfaces, and vectored thrust enable 60-degree angles of attack and the ability to turn on a dime. The Raptor is the first U.S. fight-

er able to perform cobra maneuvers—in which an aircraft rears up into high angles of attack—and J-turns, in which the craft then almost swivels in the air while pointing its weapon. “An F-15’s turning radius is 3,000 to 5,000 feet, but this plane can almost rotate in space,” Cabral says. “An F-15 requires a lot more finesse and a lot more constant practice of stick-muscle memory to get it to pull 9 Gs. The Raptor is simple: You pull on the stick and you get 9 Gs almost instantly. Little inputs on stick and the throttle give you large outputs. Its responsiveness and maneuverability over anything else airborne is instantly apparent.”

BFM for the Raptor consists of just four flights (the F-15, by comparison, requires 12). Air Force planners expect that the Raptor will spend little time dogfighting; “supercruise and stealth are so much more important,” Cabral says. In a Raptor, a visual encounter should take place only “because you choose it,” he says, “and you arrive in the merge with complete surprise.”

After BFM, pilots learn advanced combat maneuvers, with multiple airplanes working as a team. Even more differences emerge between the Raptor and its siblings.

*Number 18, the first F/A-22 delivered to Tyndall, flies over the base.*

F-15s and F-16s fly in close visual formation; because they’re not stealthy, they must work together to scan the airspace in front of them. “In an F-15, you live and die by putting your radar in the right piece of sky to find threats and ID them,” says Cabral. But looking from the ground to 60,000 feet—120 degrees of sky—takes the F-15C’s radar 14 seconds. Flying within visual formation, the flight lead takes the low half and the wingman takes the high half. A sensor called the Radar Warning Receiver indicates if an airplane or a SAM is looking at you. Flying at 500 knots (575 mph), Cabral says he alternates between the RWR and radar, while using “my eyeballs and moving my head to look for stuff. If the radars pick something up—bandits are merely green blips, and you don’t know if a blip is one airplane or two close together—I have to ask: Do I need to defend myself? Is it a threat? Or do I need to call an AWACS [Airborne Warning and Control System aircraft] and give them the information?”

Flying and fighting in the F-15 is “task prioritization,” Cabral continues. “You have to generate a mental

TS/ST. MICHAEL AMMONS









picture of the airspace and battlefield in your mind. Sometimes I even literally sketch a picture on my kneepad, all while talking on comms and cross-checking the systems.”

In the Raptor, on the other hand, the radar sweeps 120 degrees of sky instantly, and computers synthesize the incoming data and display the results on a single eight-inch-square color display. Bandits are red triangles; their flight path, altitude, and relative speed are apparent at a glance. Friendlies are green circles. Unknown aircraft are yellow squares, other F/A-22s are blue. SAM sites are depicted as yellow pentagons, the sizes varying relative to the distance at which the radars can pick up the stealthy Raptors. The Raptor’s radar range is classified, but Stapleton says he has “seen targets beyond 320 miles.” Attack and defensive displays, respectively on the right and left of the main display, can show tactical information in even more detail. The attack display, for instance, can show all tracked aircraft—“tracks”—in the current shoot list, which tracks you’ve deployed missiles against, and what the status of those missiles is. The defensive display, on the other hand, might show which tracks are illuminating the Raptor and what their range is. Says Dave “Shotgun” Lopez, a pilot in the 43rd: “The airplane is just a huge sponge in the sky soaking up information.”

Cabral recalls that in one training exercise, “I was flying a -15 with Raptors against SAMs, and the Raptor is high, ‘meching’ the space [working the radar mechanics to scan the airspace], calling where everything is. I don’t have to work the radar mechanics myself. I put the missile in the air and make the kill and no one even sees the Raptor.”

Raptors talk to one another over a secure digital link, so every Raptor in a formation knows about the others: how much fuel a wingman has, which weapons have been fired, even which enemy aircraft have been tar-

*Opposite: Two Nellis F/A-22s (foreground) and an F-15C fly in formation over test ranges near Las Vegas.*



ERIC HEHS/LOCKHEED MARTIN

*The Raptors’ arrival necessitated new maintenance and repair facilities at Tyndall. Right: Maintainers service a Raptor strut. Entrusted with the first F/A-22s, the 43rd Fighter Squadron (bottom: ex-commander Jeff Harrigian) boasts pilots with 1,000 primary-fighter hours, plus a strong respect for secrecy.*

LISA NORMAN/K-MAR INDUSTRIES/TYNDALL AFB



geted. “Everything he sees, I see, and vice versa,” Cabral says, and what they see is a real-time, constantly evolving and updated God’s-eye view of the airspace.

Because of the aircraft’s stealth and its knowledge of what the others are doing, Raptor formations can be much more widely spaced than F-15 formations; the aircraft can stay beyond visual range of one another—what’s known as “detached mutual support.” “Typically we’re outside of five miles from each other in different chunks of the sky,” says Cabral; “even if [a bogey] sees one of us, he won’t see all of us. And that gives us a significantly different tactical mindset. We can pick and choose who and when to engage.” If the Raptors are attacking SAM sites, for in-



ERIC HEHS/LOCKHEED MARTIN



stance, “it may not be necessary to kill every aircraft that’s in front of you,” says Cabral, because some may not even know he’s there. “I can get past them, get the SAMs, and then do whatever—I can fly away or I can sit up there parked or choose what to kill.”

The next portion of training is working against SAM threats and planning

*Unlike the new F/A-22s, which have special shelters, the F-15s at Tyndall are left out in the elements (below). Bottom: A pair of Eagles appear unimpressed by the recent flight of a Raptor (landing in the distance).*



ERIC HEHS/LOCKHEED MARTIN

for JDAM—joint direct attack munition—delivery. From days 50 to 60 the scenarios grow more complex: fighting against bandits that outnumber you; working in four-ship formations; night attacks; even taking out cruise missiles—with its enhanced radar and high speed, the Raptor is better suited than F-15s for going after and killing those.

The graduating ride is called a Global Strike Profile: “It’s putting everything we learn together in a high-threat missile environment,” explains Cabral. That could be Raptors escorting B-2s or F-117s, Raptors escorting Raptors, even Raptors escorting F-15s.

In sum, what the pilots learn is that the Raptor is brainy, agile, fast, and almost invisible to radar. “Based on those four tenets,” says Garland, “we say it’s best for high-threat surface-to-air environments where other weapons have to stop.” One aircraft that had to stop, he says, is the F-15C during the 1991 Gulf War. “We could attack any air threat with an F-15C, no problem, as long as it engaged us. But if that air threat decided to hide in a SAM zone and not come out and fight, we had to stop. We couldn’t chase that airplane into a high-threat environment.”

Potentially high-threat environments include China, Russia, Iran—places defended by the latest SAM batteries, which transmit information among themselves by deeply buried fiber-optic cable. If the United States decides to go in, the Rap-

tor will lead the charge. “We don’t have anything on the streets besides the Raptor that can gain access to those threats,” says Tyndall’s Stapleton. “We can use B-2s or F-117s, but they’re subsonic and can only go in slow. If a MiG-21 with an Atoll missile gets a tally on one, he can actu-



ERIK HILDEBRANDT



LISA NORMAN/K-MAR INDUSTRIES/TYNDALL AFB





ally get them, so the B-2s and -117s are limited to night strikes. Only the Raptor gives us the speed and stealth to sneak up and open the line of scrimmage 24/7."

**T**oday at Tyndall, the only threat is the pounding rain and low ceiling. The Raptors are grounded, so Cabral, Krumm, Lopez, Captain Jeremy "Huck" Durtsch, and Christopher "Moto" Niemi gather in the squadron's spotless new bar and pour a round of Balvenie single-malt to celebrate Lopez's first Raptor flight, which he made the day before. "After the sim, nothing surprised me," Lopez says, taking a sip. "I didn't feel behind the jet at all."

"It's such a giant change it's hard to fathom," says Moto. "You see everything. All you do is make battle management decisions, and you don't make bad ones. You just overrun everything with your speed and stealth. They don't even know you're there

and you're calling them dead." Says Durtsch, "It's like clubbing baby seals."

I'm having a hard time figuring out how much of their enthusiasm is due to the Raptor's seeming invincibility and how much is due to their unflappable, upbeat nature. Probably a bit of both.

Their love of the Raptor is not universally shared. At a time when Iraq is eating billions, the Army is clamoring for more bullets and armor, and the cost of the Joint Strike Fighter is escalating, the Raptor's cost—\$258 million apiece—seems like a lot for an airplane that has no competition and that will be virtually useless against what is probably the most common threat U.S. forces now face: suicide bombers. Not to mention an airplane whose job can still be done, with various degrees of success, by other aircraft. Still, says military analyst John Pike, "even if they don't have a clue why they need it now...they know that something like

*Superiority complex: The latest air superiority fighter, the F/A-22 joins a Heritage Flight over Panama Beach, Florida, with (from left) an F-15, an F-4, an F-86, and a P-51.*

the Raptor might come in handy in 2040."

But in war, unexpected things happen. In 1999, an F-117 Nighthawk, the first fighter designed for stealth, was brought down in Yugoslavia by ground fire—at night. It's one thing for a bunch of veteran pilots to practice scenarios over the Gulf of Mexico against simulated Flankers and advanced SAM sites, another for regular guys to fly it for real. And in quieter moments, that's something even Cabral acknowledges. "The F-15 has been around for 30 years and its tactics have evolved," he says. "But we don't have a lot of Raptor data points yet—we're still building them. It's a big gray area. Honestly, we don't know what we don't know." —



# AEROSCRIP

**WHO WOULD BUY AVIATION STOCK THAT'S NOT WORTH THE PAPER IT'S PRINTED ON?**

BY ROGER A. MOLA



*Aero clubs sold membership shares to raise prize money for the 1912 Gordon Bennett Race, held in Chicago. Jules Vedrines won in a Deperdussin.*

COURTESY OF TOM LAREAU



# OPHILIACS

It's 7:00 a.m. on a chill Sunday in November, and the stalls at the Montgomery County fairgrounds in Gaithersburg, Maryland, are closed. Yet a group of visitors in flannel shirts and railroad engineers' hats are heading to the cattle judging hall. Collectors and dealers—most are both—have come to find blue-ribbon specimens, but not in livestock. The stock they seek is paper, and though it is no longer traded on Wall Street, plenty will be bought, sold, and swapped at today's Railroad and Transportation Collectibles Show.

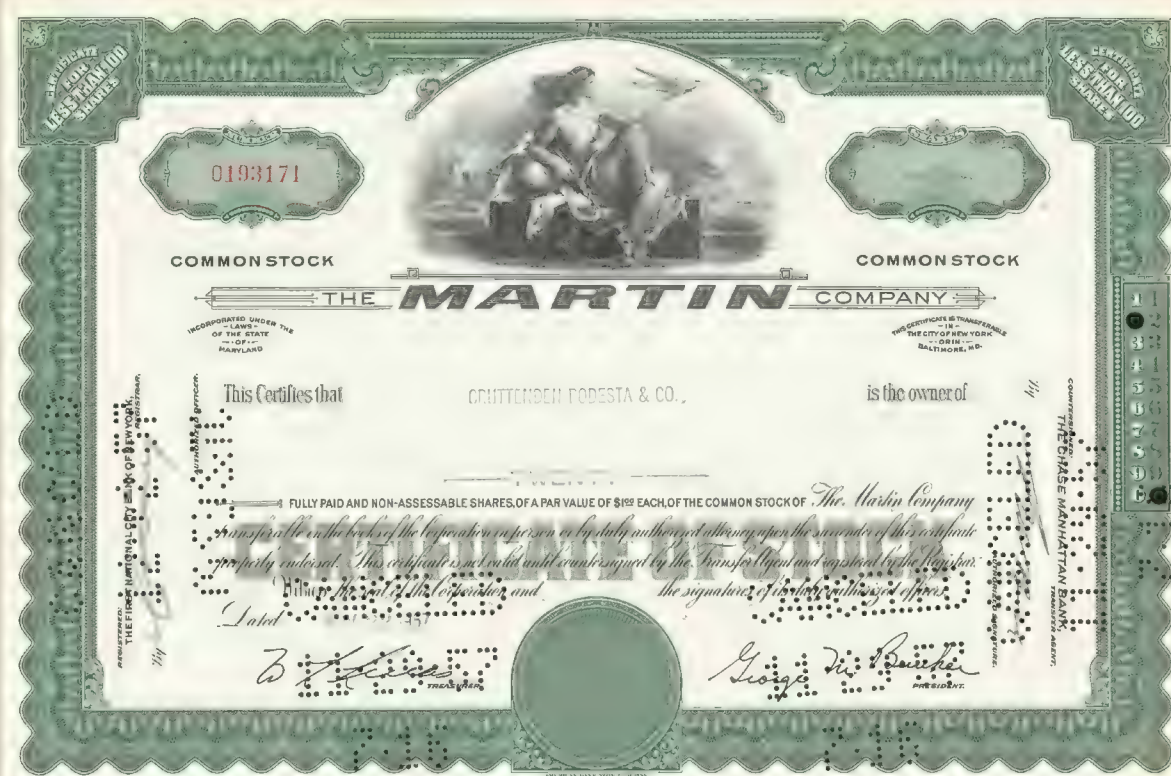
Amid the timetables, train station clocks, and other memorabilia filling the hall is a single aisle devoted to air transportation. Two tables laden with milk crates, the kind that once held collections of vinyl records, sag with stock certificates from every kind of aerospace enterprise.

Virginia dealers Tom Lareau and Bob Schell man the tables and fill time in the absence of customers with their own swaps. Each offers hundreds of aeronautical certificates, shares, warrants, and bonds—more than a century of financial flotsam.

Prices start as low as 25 cents for the most common certificates, but Schell has two stocks on display for \$75: a 1981 certificate from Lear Jet Corporation and one from the Martin Company from 1957. In searching through the boxes his rival brought, he comes upon certificates from the Custer Channel Wing Corporation. The Corporation's unusual product (see "Wrong Turns," Feb./Mar. 2003) is in the collection of the National Air and Space Museum, but because so many of its certificates have entered the collectors' market, their value

has dropped, according to Lareau, from \$25 or \$30 to about \$10.

A customer presents a Pan American Airways stock warrant, worth \$2. (A warrant is a form of security that allows the



COURTESY OF BOB SCHELL

*Collectors prize a stock certificate for its vignette, or central illustration, as well as for the historic significance of the issuing enterprise.*

owner to buy stock at a pre-determined price.) In the fall of 2003, New York's Museum of American Financial History handed out Pan Ams for free. But this one has a special appeal for Schell. Schell's wife Judy glances over.

"You know how long I looked for that?" she exclaims, snatching the warrant for a closer look. Its issue date, July 18, 1946, is Bob's birthday. The customer surrenders the Pan Am in exchange for advice about collecting.

Tom Lareau lures the customer to his table. Behind Lareau, hanging at eye level by clothespin and string, is his prize. The \$150 certificate represents shares in the 1912



International Gordon Bennett Race, the world's oldest aeronautical competition. "There are maybe 10 aviation stocks that are easy to find and the rest can get expensive," says Lareau. "On eBay, the good ones go for \$200, \$500, \$1,000 each." He dusts off the Bennett and explains what motivates most of his customers. "People are oriented to companies in a certain region, or from their childhood, and some are attracted to the signatures," he says. Early Eastern Airlines certificates, for example, bore the signature of the airline president, World War I ace Eddie Rickenbacker. "Others collect certificates because they look good," says Lareau. "I used to have a big aviation collection

until a German client bought nearly everything," says Schell. He estimates that more than a third of the 10,000 aviation stock collectors worldwide are German. Americans, he believes, are relatively new to collecting, and most started with railroad stocks. "It's the love of machines, with the romance of the Old West" that drew them in that direction, he supposes.

Another major group of aviation stock collectors resides in the United Kingdom, headquarters for the International Bond & Share Society. The IBSS publishes a quarterly magazine, *Scripophily*, the term for financial paper collecting. The society hosts auctions from South Africa to Tennessee and issues to its members a bibliography listing 80 books on scripophily.

Stock certificates enter circulation as collectibles when the companies that issue them fail and the stock can no longer be redeemed for cash, or when a cancelled stock—one that has gone through its whole life cycle, from issuance through redemption—is released by company officers, usually through transfer agents. Some stock certificates become available to collectors because the holders did not trade them in when the shares were superseded by later issuances. For example, the Lear Jet Corporation first offered stock under that name in 1964. When the company changed to Lear Jet Industries, Inc. in 1966, Lear Jet Corporation shareholders should have returned the older certificates for the new paper. In 1969, another name change, to Gates Learjet Corporation, necessitated the same kind of swap, and in 1988, the name changed to Learjet Corporation. In 1990, Bombardier Aerospace acquired the assets and operations of Learjet Corporation. Today, any stockholders who did not trade in their earlier certificates for shares of Bombardier can sell those certificates only to collectors. Bob Kerstein, a dealer in collectible stocks, sold early Lear Jet certificates to Lear family members.

There is another category of collectible stocks: uncirculated "specimens," versions of a certificate that were held by the printer, retained by a company, or included only in a sample book by the engraving artist. Specimens are rare and costly. Each is stamped with the word "SPECIMEN" and the serial number 00000. A company's Registration Statement for the Securities and Exchange Commission—known as an S-1 or A-1—would have included specimens.



LEFT: COURTESY OF BOB KERSTEIN; BACKGROUND: COURTESY OF MUSEUM OF AMERICAN FINANCIAL HISTORY

Specimens, like this Capital Airlines bond, command higher prices because, not having circulated, they are in pristine condition. Capital was absorbed by United in 1960.

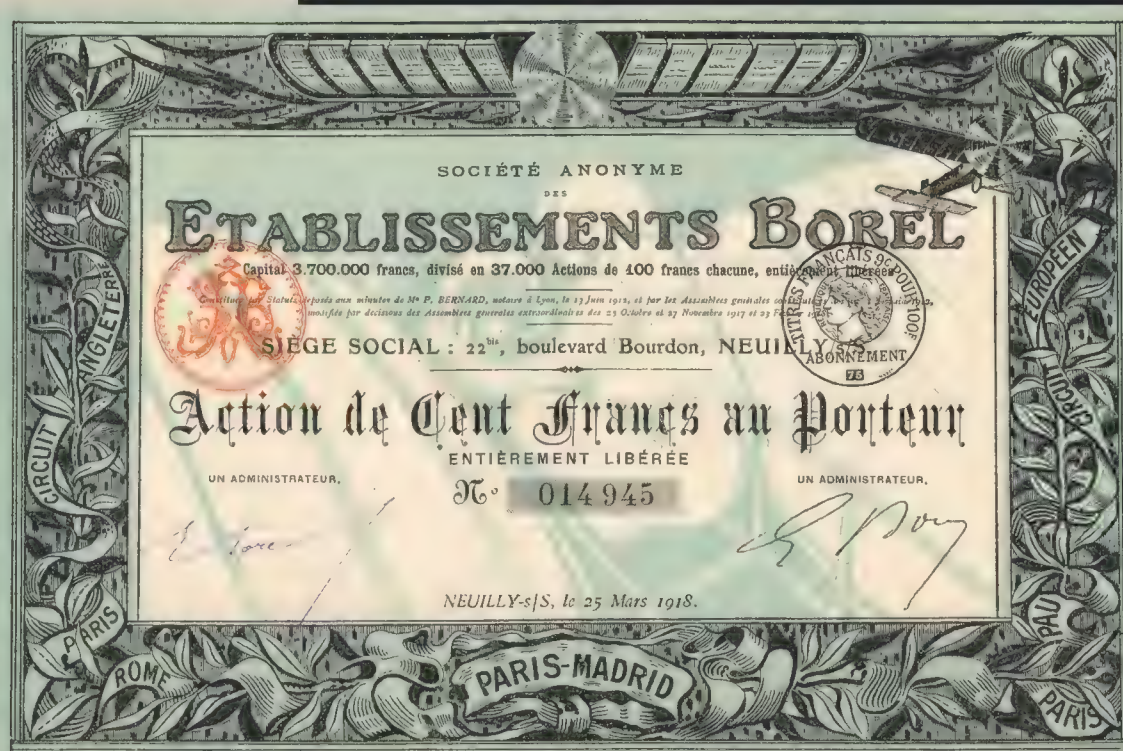


In his home office in suburban Virginia, Bob Kerstein presents his original 1936 A-1 for Bell Aircraft, with its pristine specimens and signatures of President Lawrence Bell and all officers. Kerstein's Web site, *scripophily.com*, currently lists 9,000 items. "Here's another cool one!" he says, flipping through a milk crate to find documents from Bonanza Airlines, a 1960s-era commuter line connecting Los Angeles with Las Vegas that Kerstein flew on regularly as a youngster. Another of Kerstein's treasures is a framed certificate issued in 1915 to Orville Wright, a stake of 440 shares signed by Wright's sister, Katharine, as secretary and by brother Lorin Wright as vice president. "It's a copy, or else it would sell for at least \$30,000." He pauses, then lowers his voice. "At least, I think it's a copy."

Lacking the signature of a celebrity or obvious historical value, a certificate can sometimes attract an investor by the sheer quirkiness of the concept, product, or scheme it represents. Kerstein even relishes the artifacts of a scam. His Gray Goose Airways prospectus, written by inventor and pitchman Jonathan E. Caldwell, brags: "Ours is one of the greatest opportunities yet offered." The Gray Goose was to take off with flapping wings and cruise with gas mileage of 100 miles per gallon. Today's poor investment may be tomorrow's collectible. But with more and more stocks being registered and transferred electronically, paper certificates are on their way out altogether. And the disappearance will only increase the value of paper now in circulation. ➔



COURTESY OF BOB KERSTEIN



COURTESY OF MUSEUM OF AMERICAN FINANCIAL HISTORY

*U.S. companies favored more complex vignettes (top) than those found on European certificates. The Europeans customarily used more intricate borders. The primary purpose of both was to prevent forgery.*





JSC/NASA

# Ticket to MOON



With glasses to view Apollo program footage in 3-D, audiences at a new IMAX movie will experience everything except low gravity.

by Bettina Chavanne

THE 1969 APOLLO 11 LANDING IS ONE OF THOSE EVENTS: IF YOU were alive and conscious, you remember exactly where you were when you watched the grainy broadcast of Neil Armstrong climbing gingerly down the ladder to the surface of the moon. But the quality of the picture was such that you didn't get a very good idea of his surroundings. With a new 3-D IMAX film about the Apollo moon missions, *Magnificent Desolation*, Tom Hanks wants to put the audience right there beside Neil when he first kicked up lunar dust.

The film is a collage of some of the 32,000 photographs that astronauts took with a large-format Hasselblad camera in the 300-plus hours they spent exploring the moon, lunar surface film footage, computer-generated images, and live-action re-creations. The producers effectively rebuilt the lunar landscape on soundstages on the Sony/Columbia lot in Los Angeles (conspiracy theorists will recognize this as the "real" location of the first moon landing).

Sifting through the mountains of information at their disposal required some inspiration on the part of the producers, including Tom Hanks, who says, "There are probably about 30 to 40 really famous moments that are remembered [from the moon missions]. So we decided, instead of retelling those moments that are considered classics, we wanted to go just to the left or right of those instances—

*The real Harrison Schmitt (opposite), by Tracy's Rock, and a stunt astronaut (below) share screen time.*





*Moonscape in a box: The studio created its own landing site (right). Below, Tom Hanks and director Mark Cowen study an archival image of the moon's surface.*



MELINDA SUE GORDON/© 2005 IMAX CORPORATION AND PLAYTONE (2)

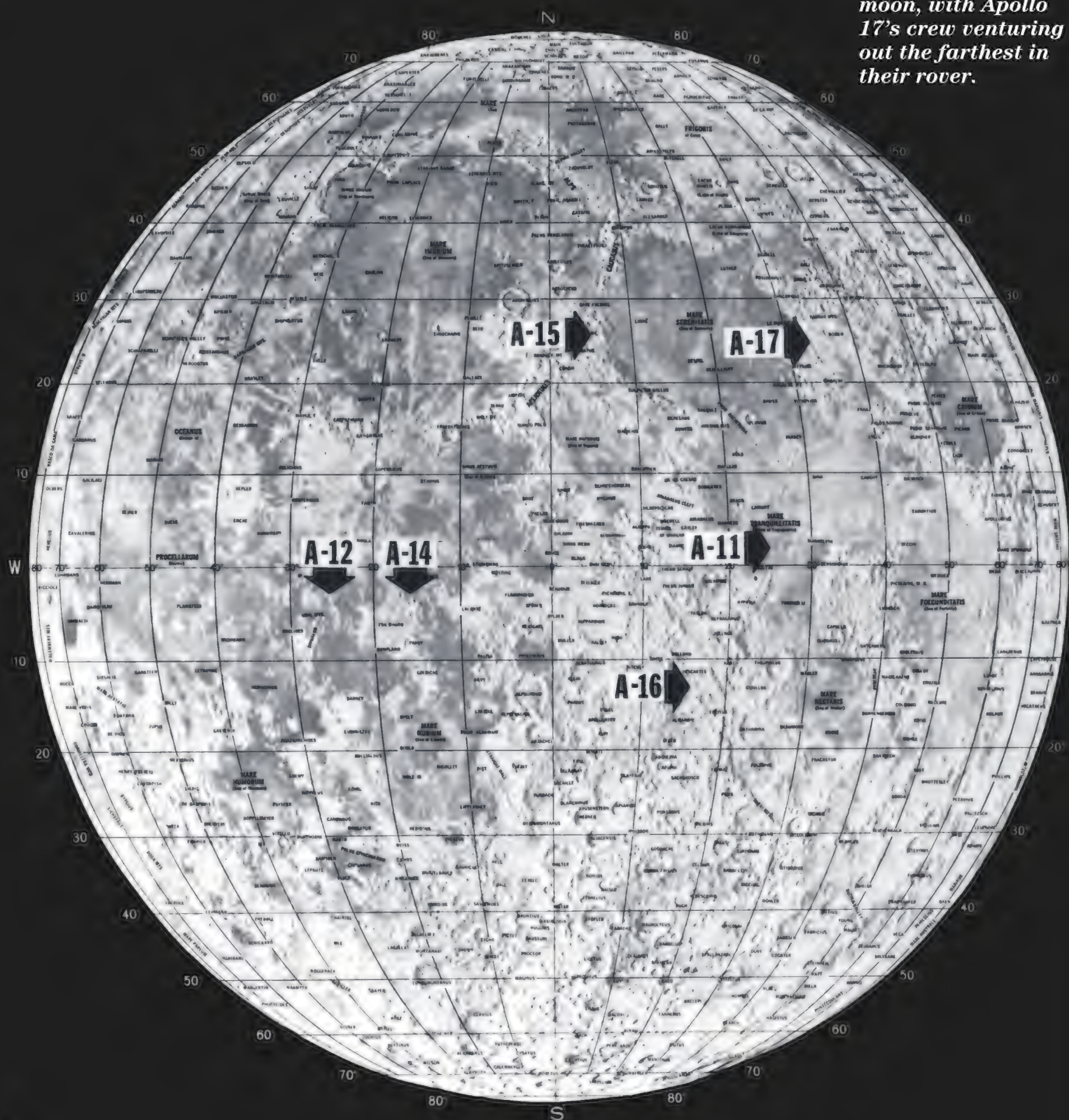
The script was compiled from detailed transcripts of each mission, including the following exchange, which inspired the movie's title: After Buzz Aldrin leapt onto the moon, Neil Armstrong said, "Isn't that something! Magnificent sight out here." Aldrin replied simply: "Magnificent desolation."

what happened prior to or immediately after that was said and done?" That method includes selecting the title for the movie. After Edwin "Buzz" Aldrin leapt onto the moon, Neil Armstrong said, "Isn't that something! Magnificent sight out here." Aldrin replied simply: "Magnificent desolation."

A cast of stars—Morgan Freeman, John Travolta, and Paul Newman, to name a few—play the parts of the 12 astronauts in voice-over. The script was compiled from detailed transcripts of each of the six Apollo missions that reached the moon—11, 12, and 14 through 17. The producers consulted the most thorough record: the Apollo Lunar Surface Journal (<http://www.hq.nasa.gov/alsj>). Historian Eric Jones, inspired to start the journal in 1988, enlisted help from many of the lunar astronauts. Jones culled NASA reports, manuals, transcripts, pictures, and audio and videotapes to put together the journal, a record of every word spoken by astronauts and by mission control to them while they were on the surface of the moon. The astronauts spent a total of about 12 days exploring the moon, and each moment of their trips was recorded on both video and audiotape.



*The Apollo missions covered a relatively small area of the moon, with Apollo 17's crew venturing out the farthest in their rover.*



NASA



*Apollo 17's Gene Cernan made tracks (this page). Opposite, top: An orbiter's-eye view of craters Hilbert (far left) and Kondratyuk (far right).*



JSC/NASA



Production designer Charles Lee and his crew came up with some ingenious ideas for faking the moon's landscape: They covered stage platforms with a layer of Styrofoam, then iced that over with an inch of concrete.



© 2005 IMAX CORPORATION AND PLAYTONE

Production designer Charles Lee and his crew came up with some ingenious ideas for faking the moon's landscape: They covered stage platforms with a layer of Styrofoam, then iced that over with an inch of concrete. With the concrete still wet, crew members "distressed" the mixture by throwing golf balls and pebbles onto the set, creating imperfections and rendering the surface more moon-like.

*Astronaut Dave Scott, commander of Apollo 15, was a technical consultant for the film. Here he advises actors on the intricacies of the Lunar Excursion Module.*

Production crew members created realistic surface dust with pulverized roofing tile, which was just the right consistency to take footprints.

The production team borrowed several set pieces from the Kansas Cosmosphere and Space Center, including an exact replica of the Lunar Excursion Module, or LEM; a reproduction of the LEM's interior; and a model of the Lunar Rover used on Apollo missions 15 through 17. (Three rovers remain on the moon today.)

Since the Lunar Rover model was never intended to move on its own after it was installed as a museum piece, it doesn't have an engine—a problem solved with the installation of a cleverly disguised golf cart motor. Production added shock absorbers as well, so the rover would look like it was bouncing across the moon's surface in one-sixth gravity.

When the producers were re-creating an actual event, they placed a monitor with the original lunar footage next to the monitor facing their set, ensuring everything from the movement of the "astronauts" to the man-made moonscape exactly matched the real footage.

On Mars, rovers do our exploring for us. But with our moon, we've had the luxury of watching fellow humans (12 in all) step off a spaceship and walk across the alien surface. It's been 33 years since a human being set foot on that dusty, mysterious landscape—which is why IMAX audiences will take such pleasure in seeing clear versions of grainy images they remember from so many years ago. ➔



**L**ate in August 2003, a Northrop F-5E swept down a test range at Edwards Air Force Base, California, the same range where Chuck Yeager first broke the sound barrier more than 50 years earlier. As the airplane flew over the dry lake bed, it shook the ground with a resounding boom. Moments later, another F-5E flew the same course at the same speed, but with a vastly different result: The boom from the second flyover was hushed, dramatically quieter than the first.

The flights were part of an experiment conducted by the Defense Advanced Research Projects Agency, NASA, and Northrop Grumman. By heavily modifying the shape of an F-5E, called the Shaped Sonic Boom Demonstrator, or SSBD, the three organizations surmised they could dampen the powerful sonic boom that normally accompanies supersonic flight. They were right. "We're going to fix the sound barrier that Chuck Yeager broke," says Roy Martin, a Northrop Grumman test pilot who flew the F-5E demonstrator.

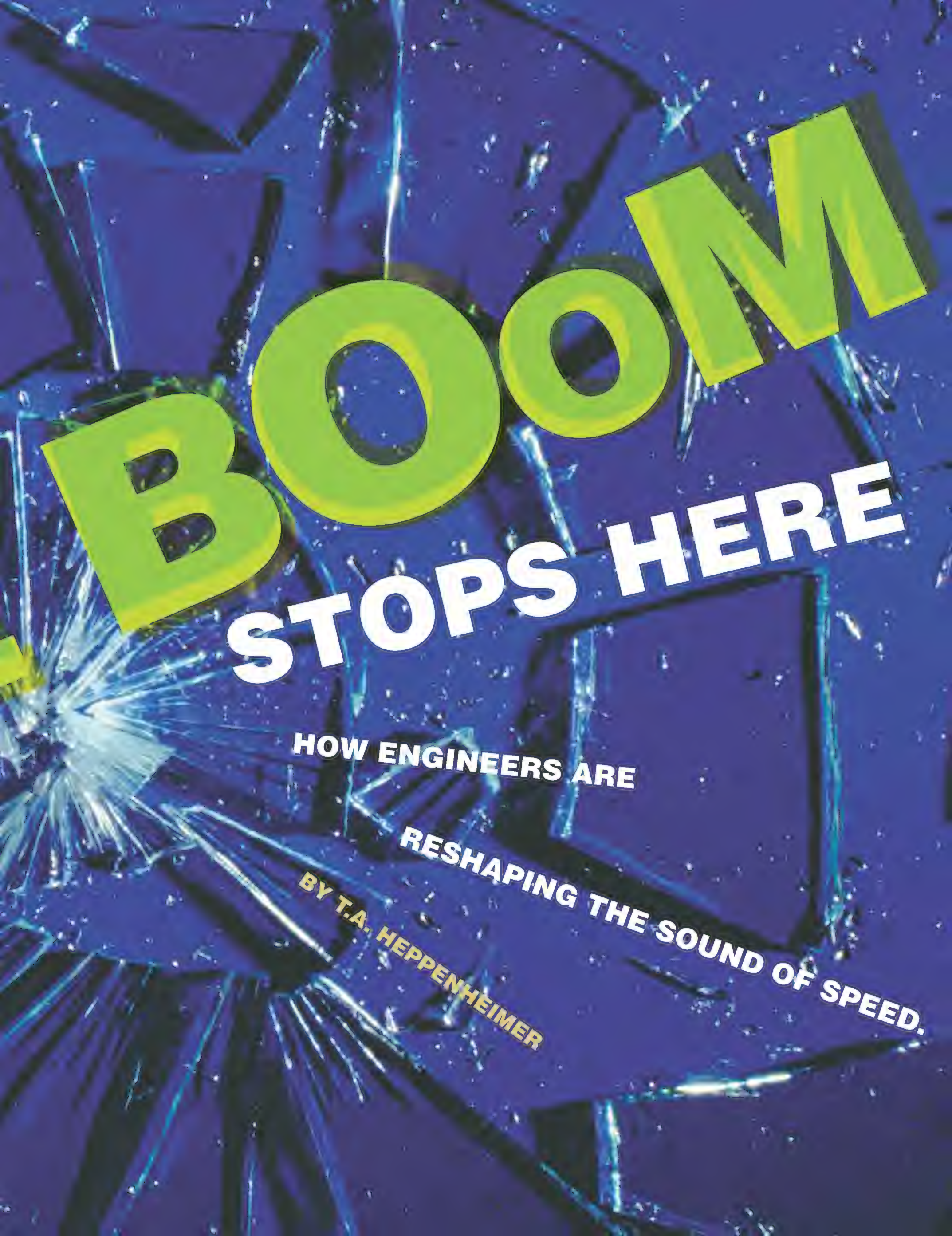
In the 1960s, two Cornell University aerodynamicists, Richard Seebass and Albert George, proposed that one way to reduce the strength of a sonic boom is to reshape the aircraft (see "Under Pressure," p. 63). They formulated their theories at a time when governments were spending money to develop a commercial supersonic aircraft. Great Britain and France were beginning to negotiate a joint program, which eventually produced the Concorde, and in 1965, President Lyndon Johnson asked Congress to commit \$140 million to fund research and development for a U.S. supersonic transport.

In 1971, political support died and the U.S. program was cancelled. NASA picked up where the failed program left off and, between 1972 and 1981, spent millions of dollars on the Supersonic Cruise Research program. Throughout that decade, NASA worked closely with the government and private industry to solve the twin problems standing in the way of supersonic airliners: noise and high fuel consumption, which is still an issue to this day.

In 1989, NASA formed a High-Speed Research program in an attempt to reduce the environmental impact of a proposed High-Speed Civil Transport. Dominic Maglieri, a member of a panel of experts assigned to the High-Speed Research program, proposed that an essential element of the HSCT would be reshaping the sonic boom's N-shaped signature. To accomplish that, the aircraft itself would have to be reshaped—exactly Seebass' theory.







# **BOOM**

## **STOPS HERE**

**HOW ENGINEERS ARE**

**RESHAPING THE SOUND OF SPEED.**

**BY T.A. HEPPENHEIMER**



Until this point, NASA's research into boom shaping had been primarily theoretical, with several small-scale models tested in wind tunnels. But no one had yet succeeded in building a large-scale test bed. Maglieri originally suggested that nose shaping be tested on a Teledyne-Ryan BQM-34E Firebee II, a supersonic remotely piloted vehicle the U.S. Navy used as a target drone. From 1989 until 1992, computational fluid dynamics and wind tunnel tests were performed on the drone, but results were elusive.

"Issues with the Firebee II came down to cost and technology," says Northrop Grumman's David Graham, lead for aerodynamic and sonic boom design on the SSBD program. "And, at 28 feet, it just wasn't long enough to provide a definitive answer as to the duration of the boom signature."

Researchers also considered modifying an SR-71 Blackbird, but that too presented challenges. "In the early 1990s, they proposed attaching blisters or bumps on the fuselage to modify the area distribution," says Graham. Making those changes to the SR-71's cross-section would have helped researchers measure shock waves as the modified parts of the fuselage met the air during supersonic flight. "The problem is that the SR-71 is costly to mod-



CARLA THOMAS/NASA DRYDEN FLIGHT RESEARCH CENTER

*With its easily identifiable "pelican" nose, Northrop Grumman's modified F-5E treads quietly in Edwards' supersonic corridor.*

ify and to operate. If they'd selected it for testing, the program would have become prohibitively expensive."

In 2000, DARPA launched the Quiet Supersonic Platform program, and asked Boeing Phantom Works, Lockheed Martin, and Northrop Grumman to come up with new concepts in supersonic aircraft design. Northrop Grumman won the competition with a proposal for an SSBD, which was, at the start, based on Maglieri's earlier

findings with the Firebee II. It was Graham who realized Northrop Grumman had a perfect test bed right in its own hangar: the F-5E. Applying Maglieri's idea of a forebody change to the relatively small and simple F-5E proved to be the right solution.

"It was important that we selected a plane that had the right kind of performance," says Graham. "It needed enough of a margin that

we could add the pelican nose, add drag, and still achieve supersonic performance. It's just like in Goldilocks and the Three Bears: The Firebee II was too small, the SR-71 was too big, but the F-5E was just right."

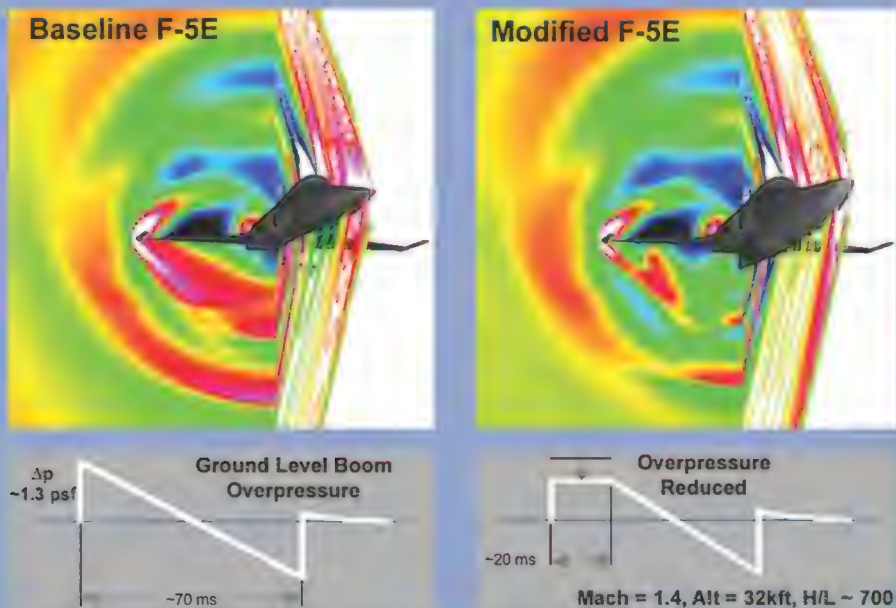
The F-5E's new "nose glove," which resembled a pelican's pouched beak, produced a strong shock wave, but weakened the shock waves produced by the wings and engine inlets, preventing those shock waves from coalescing and creating a powerful N-wave signature.

The first set of flight tests took place on August 27, 2003. As the low-boom F-5 SSBD flew high over the range, microphones on the ground recorded the sonic booms. Shortly afterward, an unmodified F-5E, based at Naval Air Station Fallon, Nevada, repeated each flight. The result: The standard boom was measured at 1.2 pounds per square foot, but the low-boom aircraft registered only 0.8 psf.

The series comprised five test flights. Three of them used both the modified and standard F-5Es, while the other two used a NASA F-15B fighter that had been fitted with a pressure-measuring probe for close-range study of the shocks from the low-boom aircraft. Flight after flight confirmed the teams' hypothesis: Carefully reshaping the aircraft reshapes the boom signature.

"Our key objective was to understand the factors that determine the

## N-Wave to Flat-top



NORTHROP GRUMMAN CORP.

*The SSBD flight tests demonstrated that the standard N-wave shock signature (left) could not only be reduced, but reshaped, into a quieter, "flat-top" signature (right).*



# Sonic Booms Cause Obesity

**D**ennis Shoffner has heard it all. “I want to make a formal complaint about what these sonic booms are doing to my physical body,” declared one irate caller. “I moved to Barstow over a year ago, and I wasn’t obese back then.” She went on to claim that the sonic booms to which she had been subjected in the past 12 months were making her fat. Shoffner listened politely, held in his laughter, and referred the call to the claims department. “A half-hour later, they chased me down the hall for sending them that phone call,” he remembers.

Shoffner is the chief of community relations at Edwards Air Force Base in California. Since 1998, he’s been fielding aircraft noise and sonic boom complaint calls from residents in the surrounding counties. Under his guidance, the complaint line has morphed into a “query” hotline because, believe it or not, not all the calls are negative. Sometimes people just want to know what kind of airplane just went boom over their house. Shoffner spends much of his time visiting nearby communities, attending meetings, and giving out his work phone number to everyone he meets. “What I found out when I went to talk to people is that they felt barraged with noise and ignored by us [at Edwards],” says Shoffner. “There’s a science to dealing with the calls. These people are in the mood to talk, not to listen.

“During their initial call, I try to capture exactly what it is they want to say, and that requires a lot of work,” continues Shoffner. “When people are upset, they aren’t good at accurately communicating their message. I try to slow them down by reading back what they told me, and I tell them I understand—because I do.”

After Shoffner takes down the complaint—on an official “Complex Noise Worksheet”—he determines which aircraft created the disturbance (it isn’t always a sonic boom that generates phone calls), then sends the information to the unit commanding officer. “The first issue is, Were they breaking the rules when they created the sonic boom?” he says. “I forward the reports, but I don’t get to hear about what happens to the pilots—if there’s any disciplinary action taken.”

Shoffner moved to the town of Lancaster, near Edwards, at the age of nine, in 1956. Back then, Century series fighters were booming the area continually.

“When they were flight testing in those years, the same rules didn’t apply,” he says. “One day, our teachers called us out into the schoolyard to watch a B-52 and some chase planes fly over. That’s when a pod dropped from the B-52. We actually got to see the X-15 launch.” Some years later, when he had a job driving a delivery truck in the same region, a B-52 flew so low over his truck that he had to pull over to catch his breath from the shock.

These days, there are two supersonic “corridors” in the area—one high-level and another for low- and medium-level flight. “We would rather test over water, but we can’t always do that in the winter,” Shoffner says. “When it’s cold and wet out, the percussion of the boom feels stronger and the

noise travels better.” In the past five years, the F/A-22 test program was responsible for many of the complaints. “People always ask me why we can’t do our testing elsewhere,” says Shoffner. “But the reality is that all of the available airspace has been carved up and taken. And then you also have more people living in areas that didn’t used to be populated.”

That includes Inyo County, to the north of the base, which comprises both the lowest (Death Valley) and highest (Mount Whitney) elevations in the lower 48 states. “Seventy percent of our noise complaints were coming from Inyo—one of the least populated counties in the region,” says Shoffner. “When I asked [the community at a local meeting] if anyone ever heard any jet noise, the room just exploded.” It wasn’t just Edwards’ jets that were booming over Inyo, it was airplanes and helicopters from naval air stations in nearby Lemoore, Fallon, and Point Mugu, as well as other National Guard and



JOHN GAY/U.S. NAVY

*Air pressure changes, combined with just the right humidity levels, result in a condensation cloud as this F/A-18 passes through the sound barrier.*

Air Force installations. Again, Shoffner used his skills in public relations to smooth the ruffled feathers of Inyo County residents. “Less than five percent of Inyo County belongs to private owners—the rest is government and public land, so there’s a lot of training going on,” he says. With a little bit of finesse, and some calls to the higher-ups at the surrounding military bases, Shoffner was able to help redirect some of the training flights and ensure a little more peace and quiet for residents. “My workday is between 7:30 in the morning and 4:30 in the afternoon, but people can leave me messages if they need to, and I try to get back to them right away,” says Shoffner. “I get a lot of weird calls around the full moon—especially about strange lights and aliens.” Neither of which is generated by booming airplanes, but then again, according to conventional wisdom, neither is obesity.

—Bettina H. Chavanne



magnitude of the pressure rise across a shock, the rate at which smaller shocks coalesce into larger shock fronts, pressure rise time, and overall boom shape,” wrote NASA project engineer Ed Haering, in a memorandum summarizing the test flights.

Still, these flights had taken place on a very hot summer day, which reduced the flight Mach values. Accordingly, NASA decided that it needed to

conduct a second series of tests.

In early January 2004, flying at 32,000 feet, the F-5 SSBD hit a speed of 1,050 mph, roughly Mach 1.4. Forty-five seconds later, the F-5E from Fallon flew the same route. The new tests covered a wider range of speeds and altitudes than those conducted in August, and served to confirm their earlier readings of a .8 psf boom. “We can’t really change the physics of a sonic boom,”

says Haering. “We’re plowing through the air faster than the air can move out of the way. The solution is to redistribute the energy around the aircraft so the result isn’t so noisy.”

Northrop Grumman hopes to apply the results of the Shaped Sonic Boom Demonstrator tests to its military jets. “Success with the shaped sonic boom flight demo required us to advance supersonic aircraft design tools well beyond state-of-the-art,” says Charles Boccadoro, Northrop Grumman’s program manager of Future Strike Systems. “Supersonic designs represent a very attractive solution for the nation’s next-generation, long-range strike systems.”

“There’s a synergy involved with low-boom and efficient aerodynamics,” says Graham. “A lot of things needed for low-boom design have direct application to a strike system.”

Graham cites laminar flow research as a prime example of research with dual applications: “Whether you apply the principles of laminar flow to a business jet or a military airplane, its improved efficiency means that the aircraft can be smaller and lighter, thus helping the sonic boom problem.”

Northrop Grumman has its own idea of what a low-boom aircraft could look like: It would be extraordinarily slender, with thin, highly swept wings supported by a strut. To shield the shock waves created by the wing as well as additional shocks created by spilled air, inlets designed to spill very little air would be mounted above the wing. The cockpit would be so well faired into the fuselage the pilot would have to rely on TV cameras to see.

By applying these principles, several groups have already prepared low-boom designs for specific types of aircraft. DARPA has come up with a “dual-relevant” concept that could take form either as a military strike aircraft or a civilian business jet. Two features of the design catch the eye: Its wings are so sharply swept that although it is 170 feet long, its width is less than 58 feet. It also is extremely slender, with similarly svelte wings.

This summer, NASA awarded four industry teams \$1 million grants each for a 5-month study to define the technology and design requirements for a

## Nose Job

*In January 2003, the U.S. Navy, under a Cooperative Research and Development Agreement with Northrop Grumman, provided an F-5E for modification. Work was performed at Northrop’s facility in St. Augustine, Florida (right), although the components were designed and built in El Segundo, California.*



NORTHROP GRUMMAN CORP. (3)



*By March 2003, a longer nose and new fairings were installed (left), along with aluminum frames, bulkheads, and composite skin panels, which were attached to the fuselage to create the “pelican’s beak” shape.*

*A month later, the F-5E Shaped Sonic Boom Demonstrator (right) was ready for test flights, missing only its shock-wave signature paint scheme.*





## Under Pressure

**W**e hear a sonic boom when there is a sudden change in pressure—a shock wave—in the air around us. The shock wave is caused by the continuous buildup and violent release of air pressure along the surfaces of an airplane traveling at supersonic speeds. During subsonic flight, pressure waves continuously move away from the aircraft in all directions, like the waves that spread out from a boat's bow as it cruises through water. At supersonic speeds, however, the pressure waves emanating from the leading edges and fuselage of the aircraft merge into one large pressure gradient, then release suddenly as they escape from the nose (the bow shock) and tail (tail shock) of the aircraft, resulting in a loud double-boom sound.

The pressure increase of a sonic boom, as experienced on the ground, is only about one to two pounds per square foot, a change someone would feel going down a couple of floors in an elevator. But because the change is so sudden, it not only registers on human eardrums as a loud noise, it also has the power to break glass and cause other structural damage.

quiet supersonic aircraft. The Sonic Boom Mitigation Project, as it is being called, will use the teams' recommendations to develop a solicitation for proposals for an actual low sonic boom demonstrator.

"It will probably be an X-plane, although we don't have a designation for it yet," says NASA's Bob Meyer, associate director for programs at Dryden. "We're approaching this fairly aggressively. We hope to award the contract to the winning company early next year and perform flight tests in 2008."

Meyer says the F-5 Shaped Sonic Boom Demonstrator tests were the catalyst for NASA's continuing its research into shaping sonic booms. "However, those tests only addressed bow shock mitigation, or shocks from the nose of the aircraft," he says. "The next step is to look at the whole airplane."

About a year ago, NASA assembled an alliance of companies called the Super 10—"super" for supersonic and "10" for the 10 industry giants, including airframers and engine companies—and asked them to evaluate a direction for supersonic research and recommend areas that would yield the highest payoff. The group recommended NASA support building a sonic boom flight demonstrator. "There are two important pieces of the program," says Meyer, who is leading the Boom Demonstrator project for NASA's Aeronau-

tics Research Mission Directorate. "The first task is to take the design tools developed over the years, validate them with flight demonstrator data, and determine if we really can propagate a low-boom shock wave to the ground from an entire airplane at supersonic speeds. The next step will be to use that data to change the current regulations prohibiting supersonic flight over land."

The length of the piloted demonstrator airplane will be about 80 to 100 feet. "Hopefully, this will be a stepping stone to a larger demonstrator sometime in the future," says Meyer. "We also have a lot of challenges for supersonic cruise aside from low-boom that we have to address in parallel with the demonstrator, including propulsion, inlets, laminar flow, and materi-

als, just to name a few." Managing fuel consumption is obviously still a hurdle as well. He adds that the program will be more than just the sum of its test flights: "There will be a lot of analytical work performed, from computer codes to ground work, including wind tunnel tests."

Boom acceptability work will include "boom boxes," booths like those used for hearing tests, in which people will experience a replicated sonic boom and then rate the strength of the sound and their reaction to it. "We'll also rate what we call the indoor response," adds Meyer, "that will tell us how a boom feeds through a structure and how it affects people inside buildings. These tests will be more complex than outdoor response tests."

Ultimately, NASA hopes to take its low-boom aircraft beyond the constraints of Edwards' supersonic corridors and over more populated areas. "We want to expose the cities to the reduced sonic boom and see if they even notice it," says Meyer.

"We had a lot of grey hair on this project," says Graham. "When we [at Northrop Grumman] first started working with Dominic [Maglieri], he sent us a résumé that said he had 45 years of experience in sonic booms. I thought it was a typo, but it wasn't." There's a certain triumph in working decades on one goal and finally seeing a pay-off. And in 2008, if NASA's newest X-plane streaks over New York City at Mach 1.2—quietly—engineers will finally reap the rewards of all those years of research. ➔

*Bizjet or strike fighter? DARPA's Quiet Supersonic Platform can be either.*

DARPA





The People *and* Planes of

# VAN SANT

A grass-strip airport just a short hop from Manhattan and Philly.

\* by John Fleischman \* Photographs by Cameron Davidson

NEW YORK

PENNSYLVANIA

Van Sant Airport ★







Arriving at Van Sant Airport on a summer morning, you set down on an undulating grass strip cut along a ridge that overlooks deep woods, manicured horse farms, and the summer-shallow Delaware River. Van Sant Airport, elevation 309 feet, has a two-room operations shack, five hangars, and eight World War II-era Stearman Kaydets, along with miscellaneous general aviation and former military airplanes, plus a field full of gliders. There are no navigation aids beyond a wind indicator, no radios, and no runway lights. For amenities, there's a phone booth, a pop machine, and, on warm weekends, a grill under the shade trees behind the office, where you can join airport regulars and visitors eating burgers and admiring the passing scene.

All day long, a parade of ground, air, and water craft comes through Van Sant—vintage sports cars, a replica Grumman amphibian, an elaborate ultralight, a husband and wife trailering his-and-hers competition sailplanes, a kit-built aerobatic stunter, a recreational helicopter, an SUV bearing a handmade wooden kayak, and many, many motorcycles. Today, the day ends with the appearance of a 1922 four-door Model T ("Running but definitely not restored," explains the owner, head under the hood as he adjusts the idle).

It's hard to believe Van Sant Airport is only about 50 miles due north of central Philadelphia and about 70 miles southwest of lower Manhattan.

Paul Ochadlick has been roaring across the grass field all morning at the controls of a Piper Pawnee, which is serving as a glider tug. Ochadlick grew up and still lives down the road from the airport. Having launched a dozen gliders this morning, he is supposed to go home and mow the lawn. Instead, he



*Van Sant has grown into Stearman Central (left: six of the airport's eight). Above: Airport operator Azhar Husain leads a Stearman convoy.*





*George Taylor, here with his especially dashing Stearman, runs a restoration shop at Van Sant.*

*The airport began as a field that John Van Sant mowed behind his house. Half a century later, it's still a daylight-only grass strip.*

lingers by the Pawnee as his relief buckles himself into the cockpit and swings the jaunty ex-cropduster down the flightline, trailing a long yellow towrope.

Out on the grassy flightline, Ochadlick's teenage son Greg is working as a line boy, wrestling the next glider into position, snapping home the tow hook, and, as the glider gathers speed, running a few steps alongside to hold a wing steady. Then tug and tow go bounding down the green and up into the clear blue.

"I can't imagine a better place to start," says his father.

Ochadlick started here, serving his time as a line boy, only he wasn't a teenager. He was 36 in 1988, gainfully employed in

aerospace materials marketing, when pilot fever suddenly seized him. To build his cockpit hours, he traded weekend sweat equity on Van Sant's glider line for time in Van Sant's flying school aircraft.

Now, with commercial ratings in both power aircraft and gliders, Ochadlick still finds it hard to tear himself away. "Maybe it's the grass, but this field is a magnet for vintage airplanes from all over this region," he says. "People in amazing aircraft just drop in for a hamburger, so you never know what you'll see next. It's almost like an airshow every weekend."

No sooner said than a transient Ryan PG-22 Recruit touches down, a vision in blazing aluminum, yellow fabric, and U.S. star-and-roundel. The visitor taxis to a stop near Van Sant's newest resident, a 60-year-old de Havilland Tiger Moth biplane in full Royal Air Force training livery, circa Battle of Britain.

The Tiger Moth is the pride and joy of airport operator Azhar Husain, who is leasing it for his flight school. Husain points out that unlike de Havilland's earlier design, the Gypsy Moth, the Tiger Moth has a few features that made it a stalwart trainer: tailwheel, brakes, and an engine positioned upside down, to raise the prop out of harm's way.

Husain offers me a hangar tour. First are the Stearmans, Van Sant's signature airplane.





They are decked out in everything from regulation Navy gray to bright check patterns. Van Sant may be the last place in America, says Husain, where a pilot with enough tail-dragger hours can check out in a Stearman and, once qualified, rent one on the same premises to solo.

Van Sant's hangar tenants range from museum-quality pieces like a 1929 Travel Air Speedwing, which looks fresh from the factory, to resurrections-in-progress like the clipped-wing Super Cub that George Taylor, who runs a restoration shop at the airport, is rebuilding from bare bones. Elsewhere are Piper J-2s and J-3s, two Aeronca Champs, a Bellanca Super Decathlon aerobatic trainer, a vintage Great Lakes biplane, a Czech Zlin military trainer, a rare World War II primary trainer called a Meyers OTW, and a pea-green Broussard, a French military bushplane that from the nose resembles a de Havilland Beaver and from the twin tails a Lockheed Electra.

Van Sant aircraft owners range from the retired dentists, lawyers, and airline pilots who never seem to go home to the wealthy collectors who never seem to be around. There's a church organist who flies his Kit Fox any day but Sunday. The Broussard belongs to an Australian stockbroker who uses it to haul his wife and kids around on weekends. And an elderly orange tom named Kitsy rules all under the title "Airport Cat."


Despite its present fleet, Van Sant's origins are about as humble and unexotic as you could imagine. In 1950, John Van Sant purchased a 300-acre farm near the town of Erwinna. Behind his farmhouse, he put up two hangar-size warehouses, mowed the pasture outside the back door, and got the Civil Aeronautics Administration to license the field as a personal-use airstrip. Though Van Sant already owned a small private airfield, it would soon be swallowed up by the Philadelphia suburbs, so the Erwinna farm was to be his fallback as well as the base for his growing sideline: buying and selling government-surplus aircraft parts.

In those years, Van Sant had a number of airplanes. His daughter, Linda Wegscheider, who still lives in the family farmhouse, remembers one Cub that Van Sant fitted with skis for wintertime commuting.

As Van Sant built up his business, he had his airstrip relicensed for commercial use as "Van Sant Airport" and leased it to a series of

*And did we mention Stearmans? At Van Sant, you can both check out and solo in one.*

# The Details



**VAN SANT AIRPORT**

NEW JERSEY

PENNSYLVANIA

Easton

Riegelsville

Milford

Frenchtown

Springtown


Van Sant Airport

Erwinna

Delaware River

0 9 MILES

**VAN SANT AIRPORT (9N1)** is at 516 Cafferty Road, Erwinna, PA 18920; (610) 847-8320. By car, it's about an hour and a quarter from Philadelphia. The airport is closed to transient air traffic from December through April. About 85 aircraft are based on the field—two-thirds single-engine, one-third gliders. About 80 operations occur each day. Glider and powered aircraft rides, lessons, and rentals are available.



*In decent weather, airport regulars grill burgers and watch the vintage airplanes come and go.*





# Don't Miss...

YOUR BUCKS' WORTH

**Dining:** In Frenchtown, NJ, try Cucina del Sol (Mexican) or Race Street Cafe (American). In Doylestown, PA, there's Madame Butterfly (Japanese) and Paganini (Italian).

**Other Attractions:** Van Sant is in prime vacation country: Bucks County. Visitors can go tubing, canoeing, and hot-air ballooning; shop for antiques; visit art galleries and artist studios; and tour historic sites. And the region boasts bed-and-breakfasts galore.



Above: The tail of a 1929 Travel Air Speedwing Special. Below: A Christen Eagle homebuilt aerobatic biplane among a gaggle of Stearmans.

operators. From 1965 to 1977, lessees Bill and Mary Jo Smeala promoted gliding and the airport's growing reputation for being antique-friendly. Then John Posey, a former Air Corps pilot who had picked up a surplus Stearman for his own amusement, took on the lease and promoted the airport with Stearman joy rides, Stearman banner towing, and Stearman flying lessons. (It helped that John Van Sant often dealt in Stearman parts.)

Posey died in 1986, and airport regulars quickly organized a proper send-off. "Just as we were coming out of the church," recalls his son Mike, "we looked up and there they were, four Stearmans in the missing-man formation."

The Smealas again took on the operating lease, and in the next decade, the airport's popularity grew. But Van Sant's increasing renown was not making all its neighbors happy. They objected to the noise—the throaty roar of the tow planes hauling sailplanes aloft all day long on busy weekends. In 1992, the local board of

supervisors, bowing to pressure from some of the residents, passed an anti-noise ordinance.

Handed a cease-and-desist order threatening \$500-a-day fines, the Van Sants and the Smealas went to federal district court. The judge ruled that the ordinance was an unconstitutional infringement on federal authority. The board appealed. The airport won again. A frosty truce ensued.



A Great Lakes Trainer (foreground) and Tiger Moth grace the flightline.

In 1996, Husain, then a flight instructor at Van Sant, stepped gingerly into the operator's position. Over time, he replaced the noisy L-19 Bird Dogs with quieter Piper Pawnees and moved the start of morning operations to a later hour. Eventually, the neighbors began to realize that an old-time airfield wasn't the worst of all possible neighbors. More neighbors, living in houses built on a defunct airport's land, would be far worse.

The road that brought the diplomatic Husain to Van Sant was long and winding. As a young air cadet in Pakistan, Husain soloed in a Tiger Moth. When his eyesight kept him out of the Pakistan air force, he entered the banking trade, first in Britain and then in the United States. Still, he kept up his pilot's ratings. When he arrived in New York in 1978 to manage his bank's Wall Street branch, Husain joined the Soaring Society of America.

A letter soon arrived, welcoming new SSA members to check out the glider program at an airport near someplace called Erwinna. Thus international banker Husain eventually found his second calling in rural Pennsylvania. Commuting from Manhattan on weekends, Husain fit in immediately at Van Sant. First, he demonstrated his skills in acrobatic gliding; then he worked as a fledgling instructor, piling up weekend hours to qualify in both powered aircraft and sailplanes.

By 1981, Husain was eager to retire from banking, buy a house in Erwinna, and pursue his dream career: part-time flight instructor. His wife agreed to the move on the condition that she could keep her dream job in Manhattan: a technical designer for the fashion house Liz Claiborne. She's commuted daily 70 miles each way ever since.

In 1996, with Van Sant's operator lease once again available, the airport regulars—







aircraft owners, mechanics, and instructors—decided among themselves that Husain had the best combination of flying and financial skills to operate the airport. He formed a tiny corporation, Sport Aviation, to lease the airport from the Van Sant family (John Van Sant had died 10 years earlier).

It didn't take a Wall Street banker, though, to see the gaping hole in any long-term business plan for Van Sant. The land was worth far more than the airport.

Upper Bucks County is prime real estate: It's where the outermost subdivisions of greater Philadelphia are threatening to bump into the outermost subdivisions of New York City and northern New Jersey. It's also beautiful: horse country, country house country, summer house country. The uppermost part of Buck's County is Tincum Township. The residents are a mix of farming families, tradespeople, and heroic long-distance commuters, along with fourth-generation summer people, reclusive movie stars, and outsiders with new fortunes. The old money and the new have always flocked to Tincum's high ground. Smack in the middle of this beautiful property is Van Sant Airport. It's no wonder that more than one developer has envisioned turning the airport into a "McMansion" subdivision.

In 2003, the Bucks County Parks Department, Tincum Township, and the Bucks County Airport Authority came up

with a solution. The Bucks County Commissioners bought the airport and its 198.5 acres of woods and fields from the Van Sant family for \$2.9 million. The surrounding land became a county park, and under the watch of the county's Parks and Recreation Department, Van Sant Airport will continue as is, or at least as it was in 2003: a daylight-only, no-instrument-landing grass strip, catering to vintage aircraft and gliders—but operating as a leased park concession, sort of like a rowboat rental or a hot dog stand.

On this sparkling June Saturday, the new deal seems to be working like a charm: Van Sant's time warp is intact. It could be last year or it could be 1981, the year Craig Foster was last here. Foster, who has just touched down in a rented Cessna, has come over to the pilot's lounge (under the shade trees) to introduce himself. He'd flown here this morning from Ardmore, a suburb of Philadelphia where he now lives and works in personnel recruiting.

Twenty-five years ago, Foster says, he all but lived at Van Sant. In 1976, when he was 13, the minimum legal age, he signed up for glider

*Still can't get enough of Stearmans? Husain gives barnstormer rides for \$110 a pop.*

*Paul Ochadlick flies a Piper Pawnee to get a sailplane aloft. Van Sant is just south of the Appalachians' front range, so the region is superb sailplane country.*





lessons. Every weekend his parents drove him to and from Van Sant, 45 minutes each way. At 14, he soloed here in a glider. Two years later, he soloed in a powered craft. "It's still the same," he says in mild astonishment, "the same rolling runway I remember, the same buildings, the same everything."

From the west, a Van Sant regular makes his final approach, swooping sharply to land short and roll straight to his starting place on the glider flightline. It's a white, two-place German sailplane, a Grob-103 Akros. It belongs to Freedom's Wings International, a



non-profit organization that takes disabled people soaring. Since 1986, the organization has been using Van Sant as its base.

The Grob's pilot is Bill Murphy, a gruff ex-Marine helicopter pilot who lost the use of his legs in a 1978 helo crash. His passenger is Will Keech, a graduating senior at Pennsylvania's West Chester College who was born with cerebral palsy and relies on an elaborate motorized wheelchair to get around on the ground. Will's father, Everett Keech, is waiting on the grass with the wheelchair as Murphy brakes the glider to a stop and pops the canopy.

In the front seat, Will Keech is flushed, sweaty, and whooping with excitement. While line boys carefully detach the canopy, four bikers in denims and tattoos who have been watching from the shade volunteer to



*Above: Bill Murphy of Freedom's Wings (in wheelchair) gives rides to disabled passengers in a Grob-103 sailplane with hand controls. Left: Husain taxis a Stearman to the flightline. Below: A de Havilland Tiger Moth DH82A, used for flying lessons.*







MICHAEL DIANTONIO, JR.

lift Keech from the cockpit and into his wheelchair. Once in the chair, he seizes the joystick controller, spins to face his father, and launches into a detailed account of cutting circles over Upper Bucks during the last hour and 15 minutes.

Meanwhile, Murphy uses his powerful arms to lever himself out of the back seat, and, once his feet are out and his lightweight hand-powered wheelchair scooted within reach, he hops out. We get to talking, and Murphy tells me that he was one of the organization's early passengers. "I hated every minute of it," he confesses of the flight. Being a useless passenger in an engine-less glider only reminded him of how far he'd fallen.

But later, Murphy became intrigued by the flying ability of Freedom's Wings instructor and president, Ray Temchus, a quadriplegic with limited use of his left hand. In 1988, flying a glider equipped with hand-operated rudder controls, Temchus became the first quadriplegic to be certified as a soaring instructor by the Federal Aviation Administration. If Temchus could do that one-handed, Murphy figured that with both arms, he couldn't wimp out.

Temchus taught him the basics. Then he showed Murphy the thrills of ridge soaring, playing tag with low-altitude updrafts kicked up along the face of the Appalachian front range. "Being able to soar like a bird is pretty much everybody's dream," says Murphy, "but it just seems extra special to take someone out of a wheelchair, put them in a glider, and show them that they can soar."

Eventually Temchus moved to Florida, and last year Murphy became president of



*Above: Does aviation get any sweeter? A Piper Pawnee tows a Schweizer 2-33 glider. Left: A Grob's-eye view of short final for one of Van Sant's runways.*

Freedom's Wings. Today, I hop into the front seat of his glider so he can show me the possibilities 3,000 feet above Van Sant.

Sailplanes are supposed to be smooth and silent, but there's nothing rougher and noisier than a glider being dragged down a rutted grass strip, especially if your seat is just above its single, unforgiving wheel. *Bang bang bump* you go, until—*whoosh*—the glider hops into the air, a kite on a string headed for 3,000 feet. Then it's smooth.

From the back seat of the Grob, Murphy shouts: "Get hold of the yellow release lever and give it a yank!" The tow plane buzzes away left while Murphy turns the glider right.

Suddenly it's silent.

Coming around to the east, you can just make out in the distance the Manhattan skyline in miniature. Off to the south, there's high-rise central Philadelphia. Below, George Washington's Delaware is full of summer boaters. Murphy noses into a thermal and the variometer jumps upward. With no engine but the sun, the glider's great white wings take you higher and higher. Van Sant Airport waits to take you back. ➤





CLAES AXSTAL/CHECK SIX

CJ HEATLEY/CHECK SIX





PHIL HIGH AND DENNIS BIELA



CHAD SLATTERY AND GEORGE HALL/CHECK SIX

## SIGHTINGS

Light is to photographers what paint is to painters, especially to photographer Phil High, who literally painted with light the one-of-a-kind Dornier Do 24 (left) that flew to last July's Experimental Aircraft Association's Oshkosh, Wisconsin event. High, who has become known there as "the night guy," made the photograph at 11 p.m. "It's an old technique," says High, who ran back and forth along the Do 24, directing a flashlight over the aircraft's surface during the 30 seconds the shutter on his tripod-mounted camera was open. Why isn't he in the picture? Because he's moving and not lit, he says. "In the available light, the camera can't record a subject that's in one spot for only a few seconds," he explains. Photographer Dennis Biela helped paint.

The tri-motor amphibian, designed in the 1930s by Claudius Dornier, was restored and flown to Oshkosh by the designer's grandson. In daylight it was mobbed by Oshkosh-goers. Only at night could High catch it alone. But in a night shot, says High, "flash can be harsh."

To each his own. Claes Axstål applies light differently. In what could be called a Jackson Pollock technique, Axstål hurls as many as 20,000 watts against a subject. He removes one of the four seats in the Saab 105/SK60 photo airplane and replaces it with 500 pounds of generators for powering a strobe. The result: his shot (opposite, far left) of the Saab AJS37 Viggen, painted red to mark the type's 2000 retirement from service with Sweden's F10 squadron and flying in formation with its replacement, the Saab JAS39 Gripen.

When Chad Slattery and George Hall photographed Clay Lacey's DC-3 at Van Nuys Airport (top), they mixed light: continuous incandescent to allow the spinning blades to register as a full circle during the long exposure, plus powerful strobe to light the fuselage and wing and delineate the airplane from its background.

And let's call C.J. Heatley a minimalist: That's good old natural sunlight on the P-3C Orion (opposite, left).



# The Glory and Glamour of Flight

## The Spectacle of Flight: Aviation and the Western Imagination, 1920–1950

by Robert Wohl. Yale University Press, 2005. 364 pp., \$39.95.

Despite its heft and size, *The Spectacle of Flight* should not be confused with your average coffee table book. Robert Wohl, a history professor at the University of California at Los Angeles and a specialist in the cultural history of aviation, has written an engaging treatise on what is arguably aviation's most dynamic era.

"A survey of cultural responses to aviation during the three decades between 1920 and 1950," writes Wohl, "would have to cast its net to include works as different as the aerial paintings and sculpture of the second wave of Italian Futurists; the beginnings of airport

architecture; the murals with which they are provided; the countless novels aimed toward a public eager for adventure tales set in the air"; comic books like *Tailspin Tommy* and *Ace Drummond*; and musical compositions like George Antheil's airplane sonatas and Marc Blitzstein's "originally acclaimed but now forgotten" *Airborne Symphony*. That's a lot of material to cover in a few hundred pages,

but Wohl succeeds in compiling a serious and thorough history while maintaining a conversational tone—even though the accompanying images aren't particularly memorable.

It's hard for many of us to remember a time when air travel was glamorous, but Wohl reminds us of its early influence on everything from fashion to film.

"[Flight] gave the West a new variant on the theme of the hero and a new type of entertainment in the form of air shows, air races, and the vicarious experience of hazardous long-distance flights followed by means of newspapers, radio announcers, and newsreels," he writes. "It is difficult for us to grasp the frenetic enthusiasm these feats inspired, all the more so because space flight in our time has failed to unleash the outbreak of such spontaneous feeling."

How did we go from being intrepid adventurers (like the fearless pilots of France's Aéropostale airmail service, traveling thousands of miles over uncharted African and South American terrain) to tepid travelers, waiting in

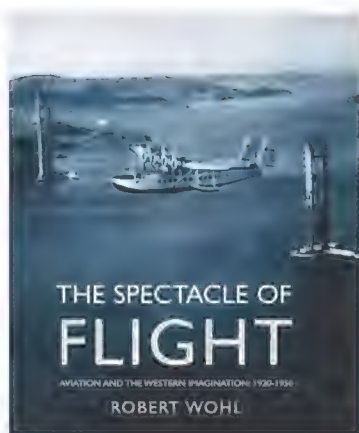


JAMES H. FARMAN COLLECTION

Constance Bennett plays a spoiled rich girl pilot in the 1938 film *Tail Spin*.

endless security lines and hoping our baggage made it with our flight? "One of the cruelest paradoxes of flight is that its relentless progress would dilute the charm of travel," Wohl concludes. Luckily, with this book, we won't soon forget aviation's power and influence on our cultural history.

—Bettina H. Chavanne is an Air & Space/Smithsonian associate editor.



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### Chopper: A History of American Military Operations From WWII to the War on Terror

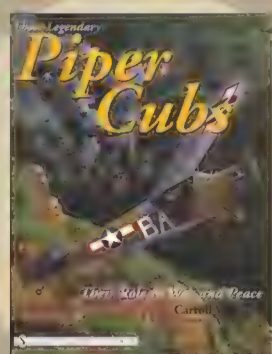
by Robert F. Dorr. Berkley Caliber, 2005. 384 pp., \$24.95.

**A**ny battle-scarred helicopter pilot will gladly tell of his daring rescues of downed pilots and fellow soldiers, but will also tell you about his own aircraft, training, and experience.

With that in mind, Robert F. Dorr opens each chapter with a brief *What Happened*, then allows the "chopper" pilots (he interviewed 77 of them) to fully recount the stories in their own words. The format at times leads to redundancy: In *Blown Up by a Booby Trap*, Dorr writes of an incident in which the helicopter in front of Lt. Col. Robert Kelly's Huey "was blown to bits by what he describes as 'a 500-pound bomb rigged as a booby trap.'" When he turns the story over to Kelly, the soldier essentially repeats Dorr verbatim.

Though there is charm in a veteran's occasional rambling, a strong edit wouldn't have hurt. Nonetheless, Dorr has collected more than 60 years' worth of memories that deserve the wade.

—Phil Scott



### Those Legendary Piper Cubs: Their Role in War and Peace

by Carroll V. Glines. Schiffer Publishing Ltd., 2005. 200 pp., \$45.

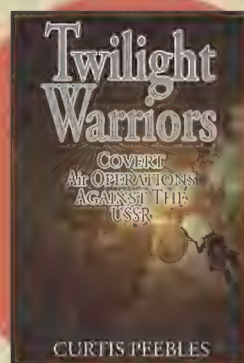
**I**f you were in the market for a car in the early 1900s, you bought a Ford Model T. And a few decades later, if you wanted an airplane, you bought a Piper Cub.

Seasoned aviation writer Carroll V. Glines has compiled a comprehensive collection of photos and memoirs about the durable, multi-role, lightweight monoplane. He also touches on the life of William T. Piper Sr., known as "the Henry Ford of aviation." Piper was a businessman who stumbled into the airplane industry, only to eventually create a legendary flying machine.

Dozens of photos illustrate the airplane's evolution from obscurity to ubiquity, as well as the dynamics of the aviation business during Piper's time.

History buffs will love this book, not only for its aviation history, but also for its nostalgic qualities, which allow you to take a step back in time to when flight was still new and the vision of William T. Piper Sr. was just being born.

—Allie Hagerman



### Twilight Warriors: Covert Air Operations Against the USSR

by Curtis Peebles. Naval Institute Press, 2005. 330 pp., \$29.95.

**F**or 30 years, the U.S. dropped covert agents into communist states, only to see them killed or turned against the West in elaborate counter-strokes, often financed with CIA gold.

Weary of losing agents, U.S. spooks in 1968 invented a charade in which most of the resistance forces parachuted into North Vietnam were phantoms: the Twilight Warriors of Curtis Peebles' book. The first man out of the plane was real, and if captured, he talked; but subsequent parachutes were found dangling empty from the trees. Those "agents" had literally melted into the rain forest. The paranoid regime wasted inordinate resources chasing the phantom resistance, which the Americans had dubbed the "Sacred Sword of the Patriot League."

Peebles is a thoughtful commentator and able writer. Though derived mostly from published sources, his account of this "twilight war" is eminently worth reading.

—Daniel Ford



### Success on the Step: Flying with Kenmore Air

by C. Marin Faure. Earmark Publishing, 2004. 432 pp., \$17.95.

**K**enmore Air didn't start out to become the world's largest seaplane operation, it just ended up that way. In fact, at the outset, the three founding partners didn't have a clue what the company was going to become. And that's what makes this story so compelling. From its beginnings with a wrecked Aeronca K on floats through a progression of aircraft including Taylorcraft, Bellancas, Fairchild 24s, Staggerwings, Cessnas, and the beloved de Havilland Beavers and Otters, the Kenmore story is as much about seaplanes as it is the people who flew them.

Along the way there are stories of roping a swimming caribou from a taxiing Norseman; landing Seabees on snow-covered glaciers; taking off from a lake shrouded in fog; and constant battles with Mother Nature. If you are an aviation fan at all, you already know how the stories turn out. But still, if you're in the mood for a bit of adventure, it's a fun ride.

—Dale Smith

## Voyage to the Planets and Beyond

by Tim Haines and Christopher Riley. DK Publishing Inc., 2005. 191 pp., \$30.

**T**his book blasts off with a lofty mission: As a companion volume to the eponymous BBC Video production recently broadcast in the United States, it relates the fictional tale, based on a wealth of detail from recent robotic exploration, of a six-year manned tour of our solar system. The book has serious flaws—a

ponderous journal-entry narrative style coupled with choppy editing between fictional and factual sections, a lack of translation from British to American vocabulary, and a typographic style that's nearly unreadable—but it nonetheless works beautifully as an illustrated reference work. Perhaps its starting point as a television show, one with a strong British voice, created some of the problems.

Most annoying was the sensation of being stopped repeatedly in mid-sentence

by unfamiliar Celsius temperature readings (or lack of any scale), speed expressed in kilometers per hour or per second, weight in tonnes or kilograms, and length in football pitches. Then there's the vocabulary, which makes sense only to readers familiar with British English: "sussed," "gas mark 27," "headtorch." Are the "shores of St. Petersburg" in Russia or Florida?

Nonetheless, the authors manage to present an awe-inspiring close-up portrait of the solar system. The





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## REVIEWS & PREVIEW

fictional astronaut team visits planet after  
planet, does a flyby of the sun, and has a  
close encounter with a comet before  
returning to the nourishing blue haven  
called Earth. We learn about punishing  
atmospheric conditions and fantastic  
landscapes. The superb illustrations and  
wide-ranging scientific data are enough to  
make this a "must-browse."

—*Nan Chase is a freelance writer in  
North Carolina.*

## Great Observatories of the World

by *Serge Brunier and Anne-Marie Lagrange.*  
*Firefly Books, Ltd., 2005. 240 pp., \$59.95.*

**A**ccording to the French authors, "great  
observatories" means only the newest  
and most powerful telescopes.  
Facilities that once ruled astronomy—  
Yerkes, Lick, even Palomar

## SHORT AND SWEET



### Ready or Not: Into the Wild Blue

by *J. Francis Angier.* *Success Networks  
International, 2003. 292 pp., \$17.*

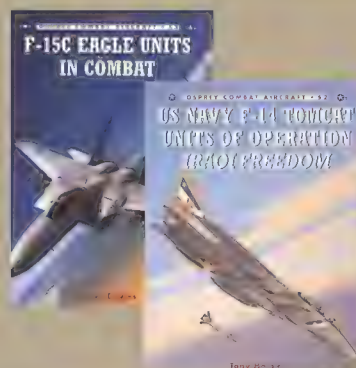
A career memoir of a B-17 pilot, with especially detailed  
descriptions of life in a *luftstalg*, a German prison camp for  
airmen.



### Camouflage and Markings of the Aeronautica Nazionale Repubblicana, 1943–1945

by *Ferdinando D'Amico and Gabriele Valentini.* *Specialty  
Press, 2005. 224 pp., \$59.95.*

You'll be an expert after reading this all-inclusive history,  
including colorful graphic designs, on the aircraft of the  
Italian Republican Air Force.



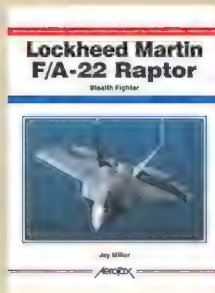
### F-15C Eagle Units in Combat

by *Steve Davies.* *Osprey Publishing Limited, 2005. 96 pp.,  
\$19.95.*

### US Navy F-14 Tomcat Units of Operation Iraqi Freedom

by *Tony Holmes.* 96 pp., \$19.95.

The two latest additions to a continuing series on modern jet  
fighters, these books feature excellent stories, photos, and  
artwork on the F-15C and F-14 in their current operational  
roles in Iraq.



### Lockheed Martin F/A-22 Raptor: Stealth Fighter

by *Jay Miller.* *Specialty Press, 2005. 127 pp., \$29.95.*

Everything you ever wanted to know about  
this soldier in the sky, from design to construction  
to test flights.



### Lockheed C-141 Starlifter

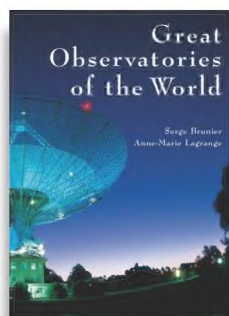
by *Frederick A. Johnsen.* *Specialty Press, 2005. 104 pp.,  
\$16.95.*

A veteran aviation writer takes you on a flight through the  
history of this famous airlifter, complete with over 250  
photos.



Observatory—don't make the cut in this coffee table book of beautifully illustrated essays; they're just mentioned for historical background (even though what some astronomers hail as the 10th planet was recently discovered at Palomar).

Most of the new major telescopes are located in areas with superb viewing and firm restrictions on outdoor lighting: Mauna Kea in Hawaii, the Chilean Andes, and volcanic peaks in the Canary Islands.



California and Arizona were once prime locations, but now only one large telescope is under construction in the continental United States, the Large Binocular Telescope on Mount Graham in Safford, Arizona. Almost every observatory

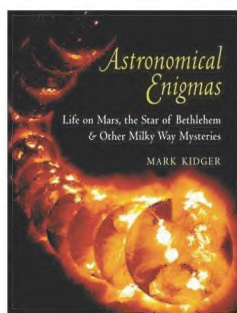
featured in the book is compared to the Hubble Space Telescope, which after 15 years in orbit still sets the standard by which others are measured. Yet the reader is left with the clear and correct impression that the astronomers of Europe now enjoy world-class facilities (mostly far from that continent) that are every bit as powerful and just as well instrumented as those of their American colleagues.

—Stephen Maran is the author of *Astronomy for Dummies*.

## Astronomical Engimas: Life on Mars, the Star of Bethlehem & Other Milky Way Mysteries

by Mark Kidger. Johns Hopkins University Press, 2005. 256 pp., \$29.95.

Was the Star of Bethlehem real and if so, what was it? How did scientists first measure the temperature of Venus and dispel early beliefs that its mysterious clouds cloaked a balmy climate? How close did our solar system really come to having a double star for a sun? These are just a few of the varied questions Mark Kidger tackles in his book.



Kidger, a professional astronomer whose day (or night) job is at the el Roque de los Muchachos Observatory in the Canary Islands, is passionate about public education, frequently giving lectures and broadcasting on the BBC. *Astronomical Engimas* is a compilation of essays that addresses the most frequent space-related

questions he's fielded over the years.

The essays are divided into three groups: a section on historical mysteries, such as the origins of Stonehenge and the aforementioned Star of Bethlehem; a section on our solar system, with inside information on our cosmic neighborhood; and a section entitled "Triumph or Disaster," which discusses how we might handle asteroid threats or terraform Mars.

The book is quite engaging, especially the historical sections, to which Kidger has devoted years of study. *Engimas* serves up an elucidating overview of the big questions in astronomy, providing the reader with a commanding level of knowledge.

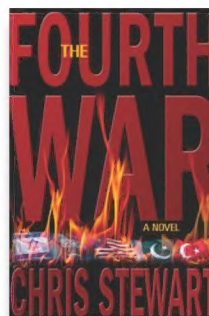
—George Whitesides is the Executive Director of the National Space Society.

## The Fourth War

by Chris Stewart. St. Martin's Press, 2005. 400 pp., \$24.95.

With the current state of events in the Middle East and Central Asia, Chris Stewart's *The Fourth War* is a timely work of fiction, especially if you're a fan of high-tech cloak-and-dagger tales. Stewart, an experienced bomber pilot, tells the story of an attempt to recover 24 nuclear warheads stolen from a super-secret Pakistani stash, before they are unleashed on an unsuspecting world.

The man tasked with leading the search-and-recovery mission is Peter Zembeic, a CIA operative who works in a group so secret its code name is changed every six months. The book is filled with the stuff a CNN reporter's dreams are made of: secret meetings in the desert, assassinations, a presidential aircraft being shot down, spy satellites, faked deaths, deceit, and, of course, the specter of global nuclear devastation. The only thing missing is 007 himself.



Along the way, readers are strapped into the cockpits of an F-16, an Su-27, a B-2, and even a '70s-era MiG-21. All in all, the descriptions of flying are accurate and vivid, but Stewart does make a couple of errors: He identifies Air Force One as a Boeing 747-400 (it's a 747-200B) and writes that the Navy's P-3 Orion is a "two-engine aircraft" launched from a carrier (it's a four-engine turboprop). With obvious glitches like that, it's tough to know which of the other technical material is real and which is just the work of a darn good imagination.

—Dale Smith is a freelance aviation writer living in Florida.

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## CALENDAR

### October 1 & 2

Fina-Commemorative Air Force Airshow. Midland International Airport, TX, (432) 563-1000, [www.commemorativeairforce.org](http://www.commemorativeairforce.org).

Helicopter Show. Olympic Flight Museum, Olympia Regional Airport, WA, (360) 705-3925, [www.olympicflightmuseum.com](http://www.olympicflightmuseum.com).

### October 7–10

Reunion: 368th Fighter Group, World War II, 9th Air Force, Marriott Crystal Gateway Hotel, Washington, D.C. (678) 333-0241, e-mail: [rgoulding@jjg.com](mailto:rgoulding@jjg.com).

### October 23

Wings, Wheels, Rotors & Expo. Joint Forces Training Base, Los Alamitos Army Airfield, Orange County, CA, (562) 598-6659, [www.expo.com](http://www.expo.com).

### November 5

Seminar on Flight Test Research. Flight demonstration by a Northrop N-9MB flying wing. Planes of Fame Museum, World War II Cal-Aero Field, Chino, CA, (909) 597-3722.

### November 6–13

Reunion: USS *Wasp* CV-18 Association. New Orleans, LA, (716) 649-9053.

### November 11

Veterans' Day Celebration. Featuring SR-71 cockpit viewings and B-17 walk-throughs. Evergreen Aviation Museum, McMinnville, OR, (503) 434-4006, [www.sprucegoose.org](http://www.sprucegoose.org).

### November 12 & 13

Visiting Nurse Association Airshow. Stuart, FL, (772) 286-1844, [www.vnaairshow.com](http://www.vnaairshow.com).

## CREDITS

**A Wartime Romance.** Mark Phelps is a pilot and perpetual student of World War II aviation.

**Sign Language.** Patricia Trenner is an *Air & Space*/Smithsonian senior editor whose sense of humor never matured past the fourth-grade level.

**The Little Engine That Couldn't.** David Noland is a writer in New York state.

**"A Full Retaliatory Response."** Thomas D. Jones says his B-52 crew training was excellent preparation for his four space shuttle missions. His book *Skywalking: An Astronaut's Memoir* will be published early next year by Smithsonian Books, an imprint of HarperCollins.

**219 Minutes on Titan.** Tony Reichardt is an *Air & Space* consulting editor.

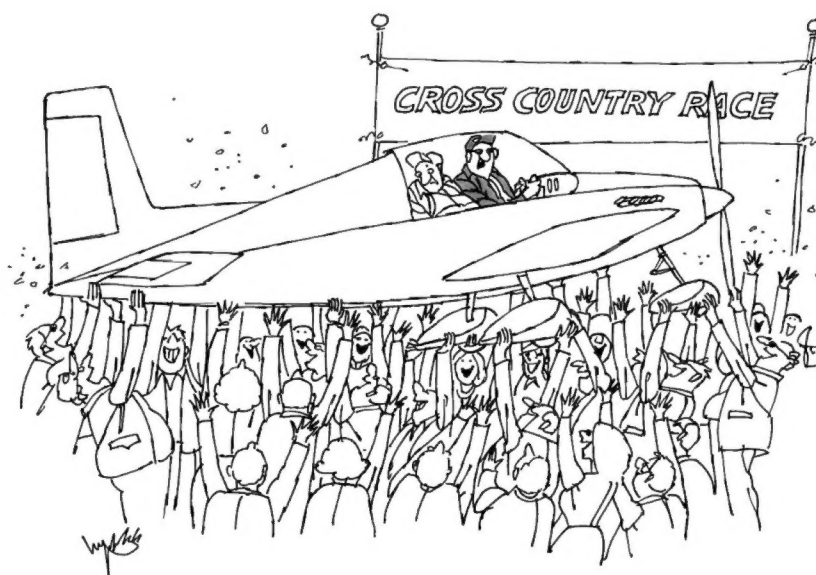
**The Raptor Arrives.** Carl Hoffman is a freelance writer in Washington, D.C., and the author of *Hunting Warbirds: The Obsessive Quest for the Lost Aircraft of World War II*.

**Aeroscripophiliacs.** Freelance aviation writer Roger A. Mola is a consulting researcher for *Air & Space*.

**Ticket to Moonwalk.** Bettina H. Chavanne is an *Air & Space* associate editor.

**The Boom Stops Here.** T.A. Heppenheimer has been a freelance writer for the past 30 years.

**The People and Planes of Van Sant.** John Fleischman writes science articles for the American Society for Cell Biology.



"This is crazy. We're in a mosh pit."



## FORECAST

### In the Wings...

#### The Other Carrier Pilots

Should that swaggering Top Gun-type in the F/A-18 happen to miss the deck, a lowly helo pilot stands by to rescue him.

#### Flying at 40 Below

Joe McBryan owns the largest fleet of airworthy DC-3s and -4s on Earth, and in Hay River, it's either them or a dogsled.

#### Hustled

Why Convair's Mach 2 B-58 Hustler is remembered fondly by its crews but not by Air Force strategists.

#### Greatest Apollo Missions Never Flown

Putting men on the moon and returning them safely to Earth was a mere fraction of what NASA had planned.

#### The Generation Lap

"Flying is ageless," Louise Thaden said. The former WASPs who raced college students in this summer's version of the Powder Puff Derby proved her right.



CAMERON DAVIDSON

From the 2005 Air Race Classic: Team 3 and their Tiger AG5B.

## ON THE WEB SITE

### www.airspacemag.com

From the 1957 launch of Sputnik to the day in 1991 when the Strategic Air Command stood down, bomber crews trained to get their airplanes airborne as fast as possible (see "A Full Retaliatory Response," p. 28). Former B-52 commander Thomas D. Jones, in a special Web posting—"Gone in 144 Seconds"—recalls the challenge of minimum interval takeoff, or MITO, the drill designed to get the maximum number of aircraft airborne in the minimum amount of time. Also on the Web: More photographs of aircraft painted with light (see Sightings, p. 72). Use the Web site to renew your subscription, buy gift subscriptions, find out which back issues are available, or send us fan mail!

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# Short and Sweet

**W**hen John Parker set out to join the ranks of aviation world record holders this year in his scaled-down P-51, *Blue Thunder*, no one—not even Parker himself—knew if setting the record was possible.

It wasn't because his Mustang wasn't fast enough. Parker's homebuilt aircraft has taken second place twice at the Reno Air Races. And it wasn't because he lacked credentials: Parker's a three-time Formula One champion at Reno who has been flying since the 1960s.

"It took four months of preparation," says Parker, 67, of Reno, Nevada, "and only 18 minutes to do it." In reality, his records—speed over a three-kilometer straight course and speed over a 15- to 25-kilometer straight course—were years in the making. Why?

The rules for the records Parker wanted to break were established many years ago, when airplanes didn't fly nearly as fast as they do today (*Blue Thunder* can fly at speeds approaching 400 mph). The faster an airplane travels, the more difficult it is to accurately measure its speed on a short course. Judges using

records," says Brian Utley, a member of NAA's Contest and Records Board who in the end oversaw Parker's record attempts. "With very fast aircraft, how do you time the flight and still maintain the accuracy required by the rules?"

Enter the Institute of Navigation, a non-profit professional society dedicated to the advancement of the art and science of navigation. The institute offered to fund a project on behalf of NAA to expand the capabilities of GPS. A commercial GPS receiver takes recordings about once per second, and locations measured by commercial GPS are not accurate to the level of precision required to verify a record.

Parker became the guinea pig for the new system, which consisted of two identical GPS units—one mounted in the airplane and one that would stay on the ground. By combining the readings generated by the ground unit (which knows its position, an accurately surveyed point, and then cross-references it with satellite readings), a standard correction was applied to fine-tune the aircraft-based unit, resulting in the most accurate data measurements possible.

So on June 4, as part of the Experimental Aircraft Association Golden West Regional Fly-In in Marysville, California, Parker set his records. On the three-kilometer course, he registered a speed of 374 mph (beating the old record by about 29 mph), and on the 15- to 25-kilometer course, he flew 371 mph (easily besting the previous record by 71 mph). For the NAA, the triumph was the tremendous breakthrough represented by the new GPS units. "We're in a

whole new environment of measurements and verification we never had before," says Utley. "It lets us deal with the higher speeds of modern aircraft."

—Dustin Gouker



W.J. PEARCE

*Verifying Blue Thunder's speed required finely tuned GPS readings to guarantee accuracy.*

stop watches couldn't record reliable times, and standard Global Positioning System technology couldn't collect enough data to be accurate.

"This was the challenge that NAA had been wrestling with regarding speed

## LOGBOOK

### The Centennial Medallion

The first in NAA's Collier Trophy Centennial Medallion Collection is now available. A special commemorative card encases a metal medallion showing the 95-year-old Collier Trophy on one side and an image of SpaceShipOne—the 2004 Robert J. Collier Trophy winner—on the reverse.



### Public Benefit Awards

NAA recently announced the winners of this year's Public Benefit Awards, a series of five awards recognizing contributions of those in aviation engaged in humanitarian efforts.

Bill Boulton won the Distinguished Volunteer Pilot Award for his work with Angel Flight Inc. in Oklahoma. Stephan Fopeano of California, won the Distinguished Volunteer Award for donating his time to Angel Flight West, Inc. Angel Flight West shared the Outstanding Achievement in Support of Public Benefit Flying Award with LightHawk. The Public Benefit Flying Team Award was presented to Angel Flight Mission coordinators from Georgia, Oklahoma, and the Eastern Region, as well as coordinators from Lifeline, Cairflight, and the Volunteer Pilots Association. And Alaska Airlines won the Champion of Public Benefit Flying Award for donating tickets to people in need for the past 20 years.

The awards were created two years ago in partnership with the Air Care Alliance, a group of humanitarian flying organizations.

*Moment & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at [www.naa-usa.org](http://www.naa-usa.org) or call (703) 527-0226.*